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THE EDUCATION BILL

IN several recent issues (NATURE, 152, 393, 427, 455, 483, 517, 545) we have dealt with the White Paper which heralded the Education Bill, beginning with a general survey, and proceeding to special aspects which in our judgment most nearly touch the real problems of education in Great Britain. We now have before us the long-awaited Education Bill, with the accompanying Explanatory Memorandum*. Let it be said at once that the Bill goes far to meet the criticism and the suggestions which we, like many others, have ventured to express.

First, however, comes an unanticipated change which happens to be of cardinal importance. At present there is no real Ministry of Education. The functions of the President of the Board of Education are vaguely defined as "the superintendence of matters relating to education in England and Wales", the result being that, however convinced the President may be that a certain step is desirable, he may have no power to act, but may only be able to offer advice and bestow his blessing. The Bill proposes a radical change. There is to be no change of name. We shall still have a Board of Education and a President (with rank of Minister), but the latter will be equipped with powers which mean that we shall have something akin to a Ministry of Education, just as surely as we have a Ministry of Works or of Labour. Any fear of over-centralization of power is allayed by the importance of the functions allotted to the local authorities. The addition of Central Advisory Councils for England and Wales respectively, charged with the duty of advising the Minister on "such matters of educational theory and practice as they think fit", is a signal that the Board is meant to be a great deal more than an administrative machine.

Broadly speaking, the White Paper was received with a chorus of approval, both in Parliament and in the country, at least with regard to its purely educational proposals. Perhaps the most widely expressed sense of disappointment related to the "exceeding lack of speed" implied in the Paper. The Bill meets this criticism by taking the bold step of fixing April 1, 1945, as the date for raising the school-leaving age to fifteen, the President being empowered, however, for a period limited to two years, to retain the age of fourteen where it is impossible to provide the necessary buildings and teachers in time. The same date is fixed for the coming into operation of provisions regarding health and physical training, the modification of the dual system, religious education, and the adjustment of the present system of local administration. The date for raising the leaving age to sixteen is to be fixed by Order in Council, as soon as the Minister deems it practicable. So also will the date on which it will become the duty of local authorities to secure the provision of the necessary facilities for the compulsory part-time education of young persons.

Another of the rather bitter cries evoked by the

* A Bill to Reform the Law relating to Education in England and Wales. Pp. xii+98. 1s. 6d. net. Education Bill: Explanatory Memorandum by the President of the Board of Education. (Cmd. 6492.) Pp. 14. 3d. net. (London: H.M. Stationery Office, 1943.)

White Paper is met by a financial allocation for technical and adult education more than three times as large as that proposed in the Paper.

The duty of local authorities to secure adequate provision of primary and secondary schools, and not merely, as at present, to keep efficient the elementary schools in their areas, is to include the duty of providing nursery schools. The provision of these schools was left as a power only by the Act of 1918, and, as the event has shown, the power has been little used, notwithstanding the acknowledged necessity for these schools from the point of view of social amelioration. In this respect, as in many others, the assent of Parliament will amount to an intimation to local authorities that the nation has made up its mind on the subject.

The other failure to carry out the intention of the Act of 1918 was that which related to the ill-fated day continuation schools, opposed by the less far-seeing kind of employer, and scarcely welcomed by boys and girls, who had no desire to be sent to school again. The Bill provides for part-time continued education, not in day continuation schools, but in young people's colleges. The change of name, though perhaps sounding slightly pretentious, is exactly in the right direction, because it implies for the young person an entirely fresh start, an increased freedom from the restraints necessary during childhood, and a new opportunity of practising self-mastery. Attendance is to be obligatory for all young persons up to the age of eighteen who are not receiving full-time education. The arrangement of times is left to the local authority, but otherwise part-time education will be similarly organized throughout England and Wales.

An outstanding feature of the Bill, representing a considerable advance upon the White Paper, is that the way is opened for better provision for physically or mentally handicapped children. Hitherto the duty of ascertainment by the local authority has been restricted to defective and epileptic children. It is now extended to all types of children needing special educational treatment, including those who have come to be known as maladjusted. Also, the requirement that a handicapped child must be certified as defective before he can receive special treatment is removed. It will be the duty of the local authorities to provide special schools for the seriously handicapped, and special treatment for the less serious cases. From our point of view there are in this subject two points of compelling interest: first, that compassion towards those who are not to be winners in life's race is one of the fine things in a democracy, and, secondly, that the remedial treatment now possible is the result of applying scientific methods. In that connexion we may mention also the more general power which the Bill confers on a local education authority to "make such provision for conducting or assisting the conduct of research as appears to the authority to be desirable for the purpose of improving the educational facilities provided for their area". In this forward step one sees the promise of the substitution of scientific method for empiricism and guesswork. A similar blend of humanity and efficiency is seen in the powers conferred upon local authorities with regard to medical inspection and treatment, the provision of milk and meals, of boots and clothing—the parent to pay according to his means or lack thereof.

One result of current discussions about public schools has been to bring to the front the general question of boarding-schools for children of the unprivileged, when that arrangement seems desirable. In response to the arguments brought forward, the Bill provides that a local authority may set up a boarding school "for pupils whose education renders their residence away from home desirable, either because their parents desire that they should be educated as boarders or by reason of the remoteness of their homes or of other circumstances". Here it may be mentioned that the Bill maintains a stony silence as to the public schools, notwithstanding the lively discussions which have occurred lately, and the numerous letters that have appeared in the correspondence columns of *The Times* and of other newspapers. It is scarcely to be expected that the same silence will be maintained during the passage of the Bill through Parliament.

As to the coming Parliamentary debate, it is devoutly to be hoped that those prophets are wrong who foresee that most of it will be taken up by lengthy and perhaps acrimonious tirades about the dual system of control and the cognate question of religious education. Let anyone examine the records of the debates on the Bill of 1870, and let him cross out the parts relating to the denominational disputes, and he will find that there is not much left. We do not want, and we are sure that the general public does not want, a repetition of that vain war of words. Apart from 'the secular solution', of which we used to hear so much, but for which the general public is not prepared, there is only one way—the way of compromise, of give and take, which is essential in a democracy, and in which the British are said to excel. We trust that almost the last word has been said by way of patient and sincere and honestly sought compromise on these questions, it being known beforehand that as no one can get the whole of what he wants, so everyone will get some of what he wants. Thus the energies of Parliament would be available for educational matters which come nearer to the business and bosoms alike of parents and teachers and administrators.

One of those matters we account of vital importance is the development of a real democracy, in which every young citizen gets the opportunity to which he is entitled by his abilities. The White Paper proposed a division of secondary education into three types, to which there should correspond grammar schools, technical schools, and modern schools. The many virtues of the existing secondary schools, which inherited the traditions of the old grammar schools, were fully recognized, as also their gradual failure to meet the needs of able children who ought never to have been attracted into a type of school predominantly academic in its outlook. For them it was proposed that the secondary technical school should be developed, taking its start from the existing

junior technical schools and technical colleges. By many critics these proposals have been denounced, the grammar school as lopsidedly bookish, and the technical school as unlikely to engender that interest in the humanities which is one of the hall-marks of the well-educated man, and without which science cannot adequately express itself.

But the chief anxiety of some of the most experienced critics has been about the proposed modern schools, which must be *the schools of the masses*. It is perfectly true that the intention is to bring these schools up to the standard of the grammar schools in point of buildings, equipment, staff, size of classes, 'amenities', and so on. But just as the existing secondary schools inherited the traditions of the old grammar schools, so these senior or modern schools will inherit the traditions of the old elementary schools, into the details of which we need not enter. The staunch adherents of the democratic ideal must now, and for years to come, insist upon the fair promises embodied in the Bill being faithfully carried out, and they may have a hard struggle. The Bill does not lay down a three-fold division of the new secondary system, but leaves the local authorities to propose their plans of development. In other words, the Bill leaves room for experiment, even in the direction of the multilateral organization of American high schools. It is to be hoped that this ordered freedom to experiment will be benevolently regarded by the Minister, and will lead to valuable results. The general ends in view would be furthered if it could be arranged that a teacher's remuneration should depend upon his qualifications and experience, and not upon the kind of school in which he teaches. It would be a happy day for British education if some of the ablest and most enterprising members of the teaching profession could feel quite free to teach in any kind of school, without forfeiting one jot or tittle of their professional rights and privileges.

SCIENTIFIC PERSONNEL IN INDUSTRY

No one who has followed the recent discussions and reports on industrial and scientific research can have failed to notice the emphasis which has been placed on the research worker himself, and on the importance of ensuring that the conditions of service are such as to attract men of the highest ability and to retain their keenness and loyalty.

There is no more welcome passage in the report* of the Industrial Research Committee of the Federation of British Industries on "Industry and Research" than that which deals with the scientific worker in industry. It is clearly recognized that on the proper position of the research worker within the organization employing him depends to some extent the power of industry to attract the best scientific brains to its service. Nevertheless, the report finds it necessary to point out that the best results can only be obtained when the research staff is taken fully into the confidence of the management and given a definite standing in the hierarchy of the organization. The research worker cannot be expected to perform his duties efficiently unless he has at his disposal all relevant information which is in the possession of the organization of which he is a member.

The report goes on to acknowledge that publication of the scientific aspects of his work is a legitimate ambition of every scientific worker, and that such ambitions are not as a rule inconsistent with the interests of firms engaged in competitive industry; on the contrary, such publication increases the prestige of the firm concerned. Again, research and development can generally only be efficient on the basis of co-ordinated team-work, with a team properly balanced as between the leader and his various grades of assistants. The personality of the leader is of the greatest importance; a successful leader is one who appreciates the ambitions and capabilities of the separate members of his team and has the gift of communicating to them his own enthusiasm and a full appreciation of the objects the team is seeking to achieve; above all, he must be able to make discriminating acknowledgment of the contribution of each member of the team to the common objective. Sir Lawrence Bragg also has emphasized the need for more inspired leaders in industrial research, and suggested that we should divert more of the national genius to industrial research by recruiting potential leaders of this kind into industry, where they should be coached for positions of high responsibility. In his view the Central (Scientific and Technical) Register could be used to locate and recruit such men.

It may be encouraging to find such statements in the report of the Federation of British Industries, but neither here nor in the comments on the benefit that has flowed from the transfer of research workers having the requisite personal qualifications to commercial, administrative and other branches of activity is there the note of conviction that makes them something more than platitudes. The more an organization is staffed on all its sides by persons having an appreciation of science and research, the more progressive and adaptable to changing circumstances it is likely to be. Little benefit indeed will be derived from increasing the numbers of those engaged on research if trained minds are not more fully employed in other branches of industry, and the general scientific outlook of industry must be raised if the understanding and application of scientific inventions, discoveries and developments by industrial firms are to be increased.

We miss in the report the urgent sense of the primary importance of seeing that scientific workers of the highest quality are first attracted to industry and then set to work under conditions which give the utmost play and stimulus to their creative powers. That consciousness clearly inspired the motion tabled in November in the House of Commons by a large number of members of all parties, asking for wider State support in planning future developments for research, teaching and higher learning as a whole, including provision for a far greater number of persons highly trained in science and technology. Again, the

* Federation of British Industries. Industry and Research: Report of the F.B.I. Industrial Research Committee. Pp. 24. (London: Federation of British Industries.)

report appears to ignore all those fundamental questions of the organization of research in relation to the personal factor which are vital and which were discussed by Dr. Alan Gregg, director for the medical sciences at the Rockefeller Foundation, in his Terry Lectures, "The Furtherance of Medical Research". Standards of remuneration must indeed be high enough to attract and to hold men of outstanding ability. They should also be such as to ensure that preoccupation with proper provision for their families does not intrude unduly on the research worker. Lord Bledisloe has rightly stressed the importance of mental concentration, quietude of mind and freedom from domestic anxieties if the research worker is to give of his best.

While, however, certain minimum standards are essential, the vital factor is the maintenance of the highest possible professional standards, the clash of mind with mind especially on the borderlands of sciences, the correction by every possible means of the ingrained evils of specialization. Refresher courses may do something to help, as may the transfer of staff within and without industry, for Lord McGowan was profoundly right in urging that scientific workers should not allow the lavish provision of scientific literature in the industrial library serving the research department of a large firm to lead them to refrain from joining professional societies and attending scientific meetings and participating in the discussions. The warning is timely and is a reminder of one respect at least in which the maintenance of the highest standards of research is a matter for the scientific worker himself.

A more generous policy in publishing the results of industrial research, as advocated by Lord McGowan and Dr. P. Dunsheath, and by Mr. Samuel Courtauld in a recent article in *The Times*, would undoubtedly have a vitalizing effect in this respect, and its indirect consequences in stimulating discussion and professional association might be out of all proportion to the direct value of interchange of information to which Lord McGowan referred, in such matters as fuel economy, heat transfer, corrosion and the design and performance of plant. Moreover, the question of the suitability of the present patent law system of Great Britain in this respect has been raised too often for it to be dismissed quite so cursorily as it was by Lord McGowan. It was raised most explicitly by Dr. Dunsheath, and Mr. Courtauld returns to the point when he urges that it is open to question whether the Government should assist research by direct contribution, or by remitting taxation, while allowing the fruits of that research to be withheld from the nation by means of patents not fully and efficiently worked.

On the other hand, as Mr. Courtauld recognizes, publication has its own difficulties. Government-maintained institutions must have a free hand, and fundamental research will be one of their main functions. The publication of fundamental discoveries must be subjected to the decision of a very high and impartial tribunal, always with an eye on possible foreign competitors. Existing interests must not be allowed to retard publication beyond the point where these coincide with public policy.

Mr. Courtauld is here entering on the difficult question of social adjustment. It may indeed be right and for the advantage of the community that a particular industry should be closed down, because of other benefits arising from the discovery or invention responsible. It may be questioned, however, whether this is relevant to the question of publication: if we make sure that such decisions affecting the fate of an industry are not determined by private interests but by public policy, which takes account of the displacements and adjustments involved, there seems to be no intrinsic reason for barring publication. Moreover, Mr. Courtauld's remarks in this connexion appear to threaten that full and free interchange of fundamental knowledge across national frontiers which is essential to scientific advance and the defence of which is one main concern of men of science in the present War.

Mr. Courtauld's challenge to the old-fashioned love of secrecy is, however, unmistakable, and many will hold with him that it has brought more harm than good to the manufacturer. Undoubtedly it undermines the relations between the research staff and management and hinders the establishment of that full confidence and understanding which play so important a part in stimulating research and bringing its conduct to the highest efficiency. The more liberal policy pursued in the United States may well be an important factor in some of the industrial achievements in that country. Mr. Courtauld is unquestionably right in holding that the maximum degree of publication and co-operation consistent with reasonable safeguards against abuse will accelerate the healthy growth of every industry based upon applied science.

It is clear, therefore, that the reports to which we have referred are far from exhausting this question of establishing the conditions under which research can be carried on with the greatest advantage. Fundamentally, we still know relatively little of the biology of invention or discovery, but in the organization and maintenance of research we are often very far from applying all the knowledge at our disposal, and these reports afford welcome evidence that this is realized and that further attempts are being made in this direction. Moreover, they indicate that industry is coming to understand that more could be done even before the scientific man enters the service of industry; the greater interest being taken by industry in technical education, and the recommendations for the more general provision of funds for the creation of fellowships, bursaries or the like at universities and technical schools and colleges for junior personnel in the industry who show an aptitude for a scientific career, are encouraging signs.

How great is the need in this respect is shown in an interim report of the British Association Committee on Post-war University Education dealing with university entrance scholarships in England and Wales*. It is not merely that the supply of scholar-

* British Association. Committee on Post-War University Education. Report on University Entrance Scholarships in England and Wales. Pp. 8. (London: Burlington House, 1943.) 6*d*.

ships is inadequate, and that in particular if adult education becomes much more widespread there should be an increase in the number of university entrance scholarships offered without an upper age limit; the methods of selection themselves receive severe criticism. The Committee holds that the present system harms a large majority of the scholarship candidates, subjecting them to conditions which place a premium on absorptive processes; it ruins altogether a small percentage of the candidates and misses some first-rate material.

The attention which industry is already giving to qualities other than purely intellectual attainments in selecting its recruits should lead it to mark very carefully what this report says about the deleterious effect of the present scholarship system upon the social life of the school, and particularly the untoward effects, on boys much more worth while than many of the successful candidates, of concentrating undue attention upon the more brilliant minority. The Committee gives a strong warning as to the necessity of carrying selection a step further. If we are to make the best of our youth, we need to get into our universities more of the leaders of the coming generation as well as the intellectual elite. We need, besides scholars of outstanding intellectual quality, men and women who combine good intelligence with qualities of character and personality, so as to be the natural leaders in other fields than those of science and learning.

This plea for character and leadership is one to which assuredly industry should not turn a deaf ear. The plea that the assessment of deep scholarship should always be accompanied by the assessment of character, and that the latter for most assisted students should carry equal weight in considering their worthiness to be admitted to a university, has strong claims on the support of industry, which is already beginning to assess its recruits by some such standards. Industry could indeed, if it chose, lend powerful support in overcoming the obstacles to the appropriate remodelling of the scholarship examinations involved in the success of any such reform, and the experience of the interview it already possesses might well be drawn upon in establishing the more effective use of the interview, with the appropriate safeguards, in examinations for entrance scholarships to universities. With that, and with real weight attached to the candidate's school record, to his English essay and to his general papers as well as to his intellectual promise in his own special branch of study, we may well find such an improvement in the quality of the recruits industry draws from the universities as will react profoundly not only on the quality of industrial research and on the application of advances in science, but also on the whole standard of industrial leadership and management. What is essential is that industry should show even more of the spirit of co-operation and open-mindedness which these reports and papers display, and tackle with more determination and thoroughness those fundamental questions of the organization and the management of research over which the Federation of British Industries tends to pass too lightly.

HISTORY OF ELEPHANTS

Proboscidea

A Monograph on the Discovery, Evolution, Migration and Extinction of the Mastodonts and Elephants of the World. By Prof. Henry Fairfield Osborn. Edited by Mabel Rice Percy. (Published on the J. Pierpont Morgan Fund by the Trustees of the American Museum of Natural History.) Vol. 2: Stegodontoidea, Elephantoidea. Pp. xxvii+805–1176+19 plates. (New York: American Museum Press, 1942.) 20 dollars.

THE Proboscidea are such very large animals that their fossil bones and teeth attracted attention in the far distant past, but only in 1698 did W. E. Tentzelius prove that giant bones found in a sandpit at Tonna in Thuringia were those of an elephant, and were not "minerale fossile, sed animale petrifactum". Before 1800 Blumenbach and Cuvier showed that some fossil elephant teeth belonged to species and genera no longer living.

Hugh Falconer, who died with much of his work unpublished in 1866, brilliantly ended another phase of the discovery and interpretation of fossil elephants by showing that they could be arranged in a morphological series providing every intermediate stage of tooth structure between a primitive mastodon and the most advanced true elephant, the mammoth. With the general acceptance of the theory of organic evolution, it was at once realized that Falconer's morphological series was in a wide sense an evolutionary one, but little real advance was made until, in 1904, C. W. Andrews found in Egypt two evolutionary stages earlier than any then known, which fitted into place before the beginning of Falconer's series; and went on to give a convincing explanation of "how the elephant got his trunk".

Dr. Andrews was well aware that the series of forms he used was not a real phytogenetic series, that Moeritherium, its earliest term, was not actually the ancestor of its successor Palæomastodon, and similarly for the other stages. But he realized, for example, that *Trilophodon angustidens* was representative of all other Lower Miocene mastodons in its characteristic greatly elongated lower jaw, and that no form with the shortened, but still long, lower jaw of his next stage, *Tetralophodon longirostris*, had been found in rocks older than the Upper Miocene.

In his mind, the important fact was the time of first appearance of each stage of evolutionary advance, the trend of evolution being established on that basis without any attempt (which would then have been impossible) to sort out independent genetic lines among the whole material of fossil Proboscidea (cf. *Phil. Trans.*, B, **196**, 101).

In 1907, H. F. Osborn began to bring together in the American Museum of Natural History materials which would enable him to apply to Proboscidea those methods of analysis of structural details which he had already conceived and used in the study of Rhinoceroses and Titanotheres. In 1920, he began that detailed work, which continued until his death in 1935. At that time, 1,240 figures, each often containing many individual drawings or photographs, had been prepared for publication, much of the text was complete and some of it in type, and an immense accumulation of notes existed. The piety of Miss Mabel Rice Percy and others has enabled the whole to be published in two magnificent volumes, of which the first was reviewed in NATURE (**138**, 860) on its

publication in 1936, while the second, devoted to the elephants and their immediate predecessors, appeared in 1942.

The circumstances of its publication have made this monograph exceedingly difficult to read and understand, for early interpretations crop out among later views, especially with respect to the age of Asiatic forms, and there is much repetition. The present volume, however, contains an invaluable and most judicious chapter by Dr. E. H. Colbert on the "Geologic Succession of the Proboscidea", which should be read as an introduction by anyone studying the whole; and a modern interpretation in footnotes corrects earlier statements of the age of each species.

None the less it is a difficult work, only to be understood by persons who have a familiarity with actual fossils and the earlier works which have been written about them. But it is invaluable, one of the greatest of all palæontological works, because it brings together an immense material, illustrates it fully by most accurate and intelligible figures, and applies to it a minute analysis of structures and a mode of interpretation which is comprehensible and logical.

According to Osborn, the actual history of the elephants is as follows. In lower and middle Miocene times there existed mastodons which can be distinguished from all others because the transverse crests on their first and second molar teeth, three in number, are separated by valleys which are not blocked by subsidiary cusps. They have long lower jaws, in common with all other mastodons of the same times. This group can be divided into three; one, distinguished by the fact that each crest on the molars is cleft into two halves, leads on to the 'American' mastodon. The second group lacks the cleft which splits the molar crests, but each crest bears four or five subsidiary cusps on its summit. The upper tusks lack an enamel belt. The third group, Turicius, is distinguished from the second by the presence of a ridge descending into the valley on the posterior surface of one end of each molar crest, and of an enamel band on the upper tusks. Each of these three groups can be followed to Middle Pliocene or later times, the lower jaw shortening and the crests becoming higher, though not more numerous, in accordance with the evolutionary trends established by Falconer and Andrews.

The third group, Turicius, is held by Osborn to include in all probability the ancestors of the true elephants. Before it had died out there appears a new genus, Stegolophodon, the oldest member of which, from the base of the Pliocene, differs from Turicius in having four crests instead of three on its first and second molars, which have very low and swollen crests with some six conelets on their summits, but retains the enamel band on the upper tusk. This genus lives on to Lower Pleistocene times.

In Middle Pliocene times appeared the genus Stegodon, with six or seven crests on its first and second molars, each bearing some nine subsidiary cusps on its summit, and having the valleys partially filled by cement. Stegodon lived on to Middle or Upper Pleistocene times, the series following the normal evolutionary course, so that the second molar of the last form has nine very high crests and the third fifteen crests.

But in Lower Pleistocene times appears the first true elephant, *Archidiskodon planifrons*, with nine or ten crests on its second and twelve on its third molars, each crest having six to ten conelets on its summit. The real difference between this animal and a Stegodon with a similar number of crests is in the fact that in it the crests have become plates with parallel sides, while in Stegodon they are wedge-shaped in section. But the very primitive South African *A. proplanifrons* and the very advanced Japanese *Stegodon auroræ* bridge the gap.

From *Archidiskodon planifrons* arose a series of elephants, with skulls of comparable shapes, in which the numbers of plates in the teeth increase to eighteen in the third upper and twenty in the third lower molars. The teeth become immensely deep, a plate measuring so much as 24 cm., compared with a maximum of 6 cm. in *A. proplanifrons*.

The final term of this series, *A. imperator*, with its varieties, reached the height of thirteen feet, and its tusks, much curved and with their inwardly directed tips crossing, may reach the astonishing length of sixteen feet. This line survived to Upper Pleistocene times. Parallel to it, and also found both in Europe and North America, are two other lines of descent, one leading to the Arctic mammoth, the other including the European *Parelephas trogontherii* and many American species.

The three groups differ markedly in the shape of their skulls, but it is often difficult to distinguish isolated teeth with certainty. The Parelephas line ranges from Lower to Upper Pleistocene, the plates of the last molar increasing in number from fourteen to thirty and the heights from 15 cm. to 24 cm. The mammoth line can also be followed from Lower to Upper Pleistocene times, the ridges increasing from nineteen to twenty-seven, while the height changes little. It can be distinguished by its high, short, pointed skull, in contrast to the rounded cranium of Parelephas.

Osborn having in this way worked out three lines of descent (the lineages of invertebrate palæontologists), which he calls sub-families, among the very close allies of the mammoths, proceeds to deal similarly with other elephants.

One family includes those elephants in which the bases of the tusks diverge widely. It also is divided into three sub-families; one of which, badly known, ends in the living African elephant, another includes a giant Indian Pleistocene form and the pigmies of the Mediterranean Islands, while the third is erected to contain the straight-tusked elephants of the European Pleistocene. Each sub-family shows some part of an evolutionary story of tooth development paralleling that of the mammoths.

Finally, a third family includes the living Indian elephants, the ancestry of which is unknown, and two allied forms from the Middle Pleistocene of the Sivaliks.

Prof. Osborn has thus made the first attempt to work out in detail the phylogeny of the 330 extinct species of Proboscidea which he regards as well founded. He has done so by the systematic search for criteria for the discrimination of closely similar animals which are members of stocks pursuing parallel evolutionary courses, and finally recognized twenty-one independent lines of this kind which may be followed for longer or shorter periods.

The most important conclusions which follow from Prof. Osborn's work seem to be as follow:

(*a*) The evolution of the Proboscidea is polyphyletic, stocks which separate from one another at any time afterwards pursuing parallel evolutionary courses.

(*b*) Comparatively inconspicuous features of the

teeth may persist unaltered, or little changed, for long periods.

(c) The evolution of such characters as the number of crests on a molar tooth is independent of the evolution of other characters of the tooth, such as the height of the crest.

(d) New progressive stocks arise from a point only a little above the base of the parent stock.

(e) Two stocks which separate from one another may differ very greatly indeed in the rate at which evolutionary changes take place in them.

(f) Progressive stock and parent stock may continue to live side by side, so that their remains may be buried in the same bed.

(g) The evolution of the Proboscidea has been a rapid process in comparison with that of horses or camels.

(h) The extinction of sub-families of Proboscidea occurred at all geological periods, twelve sub-families living on into Pleistocene times, four—two mastodons in America and two elephants—surviving to Recent time, two only still living.

The history of the elephants has thus been more completely illustrated than that of any other mammalian order, because in other cases no man has had at his command resources which enabled him to bring together in one place so much material, to have this material prepared and illustrated, to allot special points to able collaborators for further investigation, to have published papers sought for, translated and abstracted, and the notes of many years work kept in order by a most able secretary. If these conditions could be met, it is probable that many other mammalian orders and sub-orders would yield the details of an even more complete story, now existing fragmentarily in scattered publications.

It is perhaps useful, because of its great importance to archæologists, to direct attention to the fact that a South American mastodon, *Cuvieronius postremus*, has been found in Ecuador in association with human artefacts which are only 1,600–1,800 years old. D. M. S. WATSON.

THE TRAINING OF A REGIONAL PLANNER

Regional Planning

An Outline of the Scientific Data relating to Planning in Great Britain. By L. B. Escritt. Pp. 264. (London: George Allen and Unwin, Ltd., 1943.) 12s. 6d. net.

THE author of this handbook considers that regional planning is "a real study of growing importance", and that in the training of those who will undertake such planning more studies are involved than engineering and architecture. He shows the relevance of geology, the study of soils and soil surveys, of agriculture and land utilization, and a wide range of other subjects. In the space of little more than 250 pages, he has endeavoured to demonstrate the ways in which a knowledge of these subjects can be applied to problems of regional planning. He has written, generally, for the uninitiated, and has not assumed much preliminary training in any of these subjects.

The book "is addressed in particular to town planning, engineering and architectural students", but it is hoped that it will also be of interest to local government administrative officers. It may perhaps be hoped that no students of regional planning will confine their knowledge, for example, of geology, to the brief summary given in this volume: the useful lists of references to general literature and to publications specially dealing with planning will be a stimulus to much wider reading. But apart from the student aiming at professional qualifications, it may be suggested that many non-technical members of planning committees, reconstruction associations and similar bodies will find much in this volume to interest them.

An introductory chapter is followed by an attractive account of regional surveying, a subject in which Mr. Escritt evidently takes a keen interest. He makes frequent reference to the "Atlas of Croydon" and to the regional survey on which it was based: several illustrations reproduced here have been derived from that source. He strongly urges the need of such surveys as a basis for post-war planning.

In the fourth chapter Mr. Escritt discusses the education of the planner. He points out that the Scott Report expressed some dissatisfaction with the training of planners, and put forward the view that many employed as town planners are inadequately trained in the broader aspects of their work.

Mr. Escritt makes interesting comments on the syllabus prepared for the Town Planning Institute examination, and notes that at present "all universities that provide courses of study in town planning treat planning as a section of architecture, or include it as part of the work of an architectural department". He puts forward tentatively a scheme of study for those who enter the profession of planner via the universities. He suggests that this course should include work in geology, agriculture (including soil survey and forestry), economics, engineering (with some mathematics, physics, surveying, municipal engineering), architecture, regional surveying and planning. Obviously, a course designed to cover such a wide range of studies would need to be of longer duration than most degree courses, while the provision of a unified scheme of instruction in such a field would present problems of great difficulty. It may be wondered whether the training of regional planners would not be more satisfactorily approached by way of certain existing degree courses, with subsequent postgraduate instruction in those subjects which are not represented in the curriculum for the degree. Certain people would thus approach the problem with a training in engineering or architecture, others with a more general background of science or geography. For some types of regional planning it is likely that an honours course in geography, including surveying and some geology, would provide a better training in the broader aspects of the problem. Indeed, many will think that it is preferable for undergraduates to follow such courses before embarking on vocational training. If we are to have a body of professional planners, it may be most desirable to give only sufficient technical training to enable them to know which experts should be consulted.

In subsequent sections the author deals with "The Earth and its Products" (geology, soil, agriculture), "The Water Cycle" (drainage, water supply, sewerage), "The Town", and "Transport". Much ground has been covered, and Mr. Escritt has taken advice from a long list of specialists in order to make his work authoritative. As a small detail, a question may be asked regarding the use of the word 'hachure' on pages 48 and 50, which is not in accordance with the familiar practice in Great Britain.

A. E. TRUEMAN.

Formalization of Logic

By Prof. Rudolf Carnap. (Studies in Semantics, Vol. 2.) Pp. xviii+159. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1943.) 16*s.* 6*d.* net.

THE starting-point of Prof. Carnap's work is the distinction between two aspects or tendencies in logic. On one hand, there is the tendency to emphasize form, the logical structure of sentences and deductions, relations between signs in abstraction from their meaning: this is Hilbert and Bernays' *Beweistheorie*, Carnap's *syntax*. In contradistinction to it is the emphasis on meaning, interpretation, relations of entailment and compatibility as based on meaning, the distinction between necessary and contingent truth, etc.: this is *semantics*, and corresponds generally to Hilbert and Bernays' *mengentheoretische Logik*. Prof. Carnap is planning a series of studies on semantics, of which the volume under review is the second (the first being an "Introduction to Semantics"); it deals with the application of his methods to a criticism of the formalization of logic, that is, its representation by a formal system or calculus. The problem is to determine to what extent the logical calculi that have been constructed hitherto have actually effected the task of formalizing logic in such a way that the principal logical signs can be interpreted only in terms of the accepted logic of meaning; a question which the author answers in the negative. He shows, however, that a full formalization of propositional logic, and also of the logic of functions, can be effected by making use of new basic concepts, the most important step being the introduction of *junctives*, that is, of sentential classes in conjunctive and in disjunctive conception.

The book is an important contribution to the development of its subject.

Mathematical Statistics

By S. S. Wilks. Pp. xi+284. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1943.) 25*s.* net.

IN the preface Dr. Wilks makes the remark, "If and when the present notes are revised and issued in a permanent form", which suggests that the author does not need reminding of the disadvantages of giving his work to the world in a paper-covered volume of litho-printed typescript. The reviewer has certainly found this format uncomfortable.

As to substance, it is clear that Dr. Wilks has industriously gathered much material from the periodical literature, rewritten it in a consistent, if austere, mathematical notation, and thrown overboard as superfluous almost all discussion of relevance and applicability. Whatever value the course of lectures on which it is based may have to the mathematical students who take them, it seems to give no insight into *why* any particular problem should be propounded, or as to the function of mathematical reasoning in improving statistical methods. Time after time a perfectly competent, though perhaps arid, section closes with a note of finality, without a hint of the wider horizons which might have been disclosed.

The book as it stands may well be useful to some, who occasionally need to refer to a careful and precise statement on some special point. They will not find it elaborated, or exemplified; and may well be disappointed, on the purely mathematical side, by the author's pedestrian style, for the development of mathematical statistics has not really been poor in those flashes of originality and penetration which mathematicians sometimes call 'artifices'. Dr. Wilks should not disdain to reproduce such work, for, like all good artistry, it gives much pleasure, without detriment to practical aims. R. A. F.

Oddities of Natural History

By Eric Parker. Pp. 228+8 plates. (London: Seeley, Service and Co., Ltd., 1943.) 12*s.* 6*d.* net.

READERS of the *Field* will be familiar with the kind of letters that find their way into the correspondence column of that journal. This column serves as a sorting-house for the unusual incidents and observations which are little known in the animal kingdom and for which we are deeply indebted to so many 'amateur' naturalists. In order that the more significant of these observations should be available in readily accessible form, Mr. Eric Parker has made an exhaustive examination into past issues of the *Field* over many years, and his collected findings are set out in this book. It will be of most value to those actual or would-be correspondents to the *Field* whose propensities enable them to interpret the behaviour of animals in terms of human sentiment and emotions. They will read the book with avidity. Naturalists who find the anthropomorphic and teleological assumptions a deflexion from rational objectivity will find much to irritate them. Parker's approach is in direct contrast to that of the writer whose recent book on the life of the robin showed how it is possible to maintain the strictest regard for exact observation and interpretation without in any way concealing one's love for the subject being studied. T. H. H.

A Star Atlas and Reference Handbook (Epoch 1950)

For Students and Amateurs. By Arthur P. Norton; the Reference Handbook by J. Gall Inglis and A. P. Norton. Ninth Edition. Pp. xvi+90. (London and Edinburgh: Gall and Inglis, 1943.) 15*s.* net.

THE first edition of this work appeared in 1910, and this latest edition—the ninth—contains a number of alterations to bring it more up to date. Stars from the Revised Harvard Photometry down to magnitude 6·35 have been charted, and all nebulæ, except those of Messier and those classed by Herschel, have received the N.G.C. numbers. Small circles are used to indicate all variable stars which attain the sixth or seventh magnitude at their maximum brightness. The recommendation of the International Astronomical Union regarding the galactic equator and poles has been adopted, so that these differ a little from those shown in the maps of the earlier editions. In the earlier maps, limited abbreviation lists were printed in the margins, and these have been replaced by a complete list occupying a page, preceding the charts.

In addition to the value of the work as a star atlas, it contains most useful and authoritative information on star nomenclature; astronomical terms; the galaxy and the stars; spectroscopy; the sun, moon, and planets; the care and use of the telescope. It is remarkable that so much reliable detail has been condensed into a little more than fifty pages, and the provision of an index at the beginning of the book enables one to turn immediately to the page which supplies the necessary information. An astronomer's library is incomplete without a copy of this valuable work.

DICHROISM

By Dr. W. D. WRIGHT

Imperial College of Science and Technology, London

"Will all great Neptune's ocean wash this blood
Clean from my hand? No, this my hand will rather
The multitudinous seas incarnadine,
Making the green one red:"—*Macbeth.*

IN the tough and stirring days in which he lived, Shakespeare can scarcely have failed to notice that a dilute solution of blood is yellow in hue instead of red, but at least he had no opportunity to learn that the same change of hue is also apparent when blood corpuscles are examined under a microscope. This observation, which has been the subject of recent correspondence in NATURE[1,2,3], appears at first sight to be one of those odd effects which can only be explained by reference to some peculiarity of vision. Actually it is an interesting and important example of the general phenomenon of dichroism, an all-embracing term used to describe the changes in hue which some media and surfaces undergo in certain conditions. Thus dichroism includes changes in hue which are observed with some media, such as blood, when their thickness or concentration is varied, the very striking and dramatic changes in colour of certain dyed materials when viewed successively in daylight and in artificial light, and the undertone of a pigment which is observed to differ in hue from that of the mass of the pigment when the latter is greatly extended with white. While it is true, as will be seen later, that certain visual factors are involved, yet the phenomenon has an essentially physical origin which is revealed when calculations are made to determine the spectral composition of the light reaching the eye.

The coloration of a medium is due to the freer transmission of some parts of the visible spectrum than others; thus a pigment which transmits mainly in the long-wave end of the spectrum will be red, one which transmits both the red and blue radiations will be purple, and so on. If, then, we wish to discover how the colour of a medium changes on reduction in thickness or on dilution, we have first to derive the spectral transmission curve for each thickness or concentration. As an example, consider a hypothetical medium in which the transmission factor T_0 for unit thickness and unit concentration of the medium is given for each wave-length in the visible spectrum by curve A in Fig. 1. In this case we have maximum transmission in the green at a wave-length of $0 \cdot 52\ \mu$ with a rapid and roughly symmetrical decrease on each side of the maximum, and we can conclude that the sample will possess a deep green colour. Further, we can use curve A to calculate the transmission curve for other thicknesses (or concentrations) by applying Beer's and Lambert's laws. These laws can for the present purpose be conveniently expressed by the equation

$$T = T_0^{cl},$$

where T is the transmission factor for wave-length λ for a concentration c and thickness l, while T_0, as stated above, is the transmission factor for the same wave-length but for unit concentration and unit thickness. (This relation is satisfactory, provided the reflexion losses at the surfaces of the medium are neglected.) Applying this equation for the cases when $c = 1$ and $l = \frac{1}{3}$, $\frac{1}{10}$ and $\frac{1}{30}$, we obtain three new transmission curves B, C and D respectively (Fig. 1).

Reduction in thickness is seen to increase the transmission at all wave-lengths, but it will also be noticed that the increase is relatively very much greater at those wave-lengths which are most absorbed. The extent to which the green wave-lengths are in excess of the other radiations thus steadily diminishes with reduction in thickness so that, with the thinnest specimen, curve D, the transmission curve shows only a slight decline on either side of $0 \cdot 52\ \mu$. It is then easy to understand why, when each specimen is illuminated in turn by a beam of white light, the deep green coloration becomes progressively paler or more desaturated until, in the case of curve D, it is reduced to a white with merely a tinge of green.

Since no obvious change of hue will accompany the desaturation, the effect would not appear in any way abnormal and would give no occasion for comment. This, however, is due to the hypothetical absorption curve assumed in Fig. 1, a curve which is more regular and more symmetrical than that found for most absorbing media. It is not difficult to see that if there had been a subsidiary maximum of transmission at some wave-length other than $0 \cdot 52\ \mu$, say in the red, then the relative transmissions of red to green would have changed with different thicknesses of the medium and the hue of the specimen would have moved from green towards the yellow as the red component in the transmitted light became increasingly effective. Or again, if there had been some heavy absorption at a particular part of the spectrum, then when a very thin layer was examined, all wave-lengths except those in or near the absorption band would be

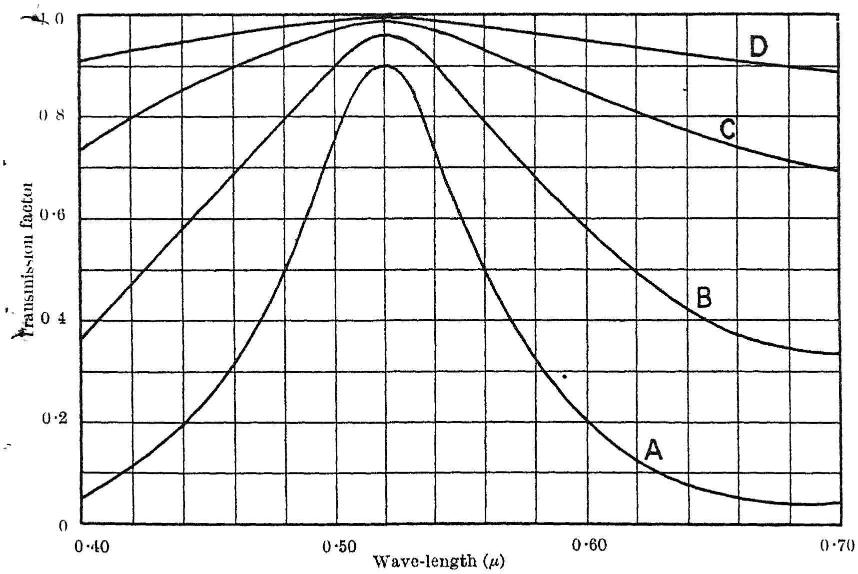


Fig. 1. SPECTRAL TRANSMISSION CURVES FOR DIFFERENT THICKNESSES OF A HYPOTHETICAL GREEN MEDIUM.

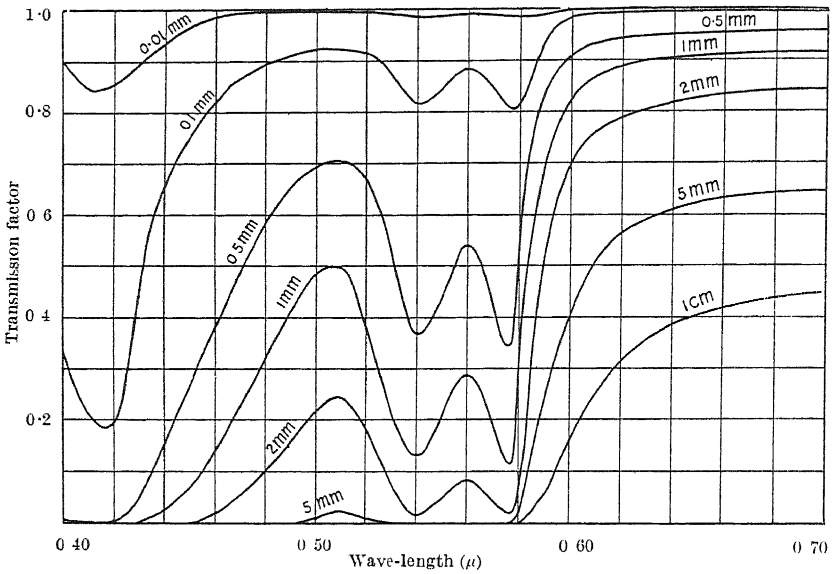


Fig. 2. SPECTRAL TRANSMISSION CURVES FOR DIFFERENT THICKNESSES OF OXYHÆMOGLOBIN (1 PER CENT CONCENTRATION). THE THICKNESSES OF EACH LAYER ARE SHOWN AGAINST THE CURVES.

transmitted with little loss in intensity, yet within the absorption band the reduction might still be appreciable. In that event, the specimen would acquire a hue complementary to that of the absorbed wave-lengths.

As it happens, the transmission curve of hæmoglobin shows that both characteristics—a strong absorption band and a subsidiary transmission maximum—are present to cause the change in hue from red to yellow which is observed with decreasing thickness and concentration. Thus, from the colorimetric point of view, the most important features of the transmission curve of blood are the high transmission at the long-wave end of the spectrum, the secondary peak in the transmission at a wave-length of 0·51 μ and the very strong absorption band in the violet at 0·42 μ.

The complete transmission curves of oxyhæmoglobin (1 per cent concentration) for thicknesses ranging from 1 cm. to 0·01 mm. have been calculated from data given by Heilmeyer[4] and are illustrated in Fig. 2. It is seen from this diagram that for the thickest layers, the only radiations transmitted in any strength are those at the red end of the spectrum, and it is this transmission which is responsible for the deep red colour normally observed. For layers of intermediate thickness the transmission around 0·51 μ in the green and blue-green becomes comparable to that in the red and will cause some change in the hue towards the orange or yellow, assisted also by the transmission at 0·56 μ. For very thin layers, on the other hand, there is practically complete transmission of all wave-lengths except in the violet, where some significant absorption still occurs. This will have the effect of tingeing the layer with the hue complementary to violet, namely, yellow, and will therefore introduce a change of hue of the same character as that caused by the transmission in the green. The similarity in the trend of the two effects is, however, a coincidence; if, for example, the strong absorption band had been located in the yellow while the absorption in the blue had been less severe, the hue at intermediate thicknesses would have first moved towards the yellow, yet in very thin layers it would have shown a slightly bluish tinge.

Although the spectral transmission curve of a medium gives a complete physical picture of the changes in light transmission which occur with change in thickness, the estimation of the colour as such can at best only be approximate, since no account is taken of the manner in which the different spectral radiations combine in the eye. A more complete analysis may be achieved by expressing the colour in terms of a trichromatic equation on the C.I.E. system[5], in which the quality of the light is defined by the proportions in which three reference stimuli have to be mixed additively to produce the same colour sensation as that produced by the light under investigation.

The methods involved in colorimetric calculations of this kind are now well established and are employed extensively in technical problems, although there are many persons interested in colour to whom they are still unfamiliar. The experimental foundation for the system depends on the fact that a colour can be matched by a suitable mixture of three radiations, and further, that the quantities involved in the match obey the ordinary rules of arithmetic; that is to say, if the brightness of the test colour were halved, the amounts of the three matching radiations would also have to be halved to maintain a match, and so on.

Assuming that we know the amounts of the three reference stimuli which would be required to match unit energy of each monochromatic radiation in the visible spectrum, we can, by a process of multiplication and summation, reduce any beam of light, as defined by its spectral energy curve, to the visual equivalent of three stimuli mixed in the correct proportions. This result can be expressed by a tristimulus equation which, on the C.I.E. system, takes the form of an equation of the type

$$C = x'.X + y'.Y + z'.Z.$$

In this equation X, Y and Z represent the reference stimuli which have an internationally specified significance, while x', y' and z' represent the amounts of the stimuli required to match the colour C. We are in many cases only interested in the relative amounts of X, Y and Z, and it is then convenient to reduce x', y' and z' proportionately to make their sum unity, so yielding the unit trichromatic equation

$$C = x.X + y.Y + z.Z,$$

in which $x + y + z = 1$. Further details of the system may be found elsewhere[6,7,8].

To apply the method to the case of hæmoglobin, we must first define the quality of the illumination which is to be used when viewing the different layers of blood. It will be convenient to assume the use of one of the standard illuminants for colorimetry, namely, the C.I.E. source S_B which, with a colour temperature of 4,800° K., has a quality somewhat

similar to daylight. From the energy distribution of the light radiated by this source and from the transmission curves of oxy-hæmoglobin given in Fig. 2, the spectral composition of the light transmitted through each layer can be calculated. From the colorimetric data given in the C.I.E. tables, the relative amounts of X, Y and Z required to match each layer can be calculated on the lines indicated above, and the results recorded on the chromaticity diagram.

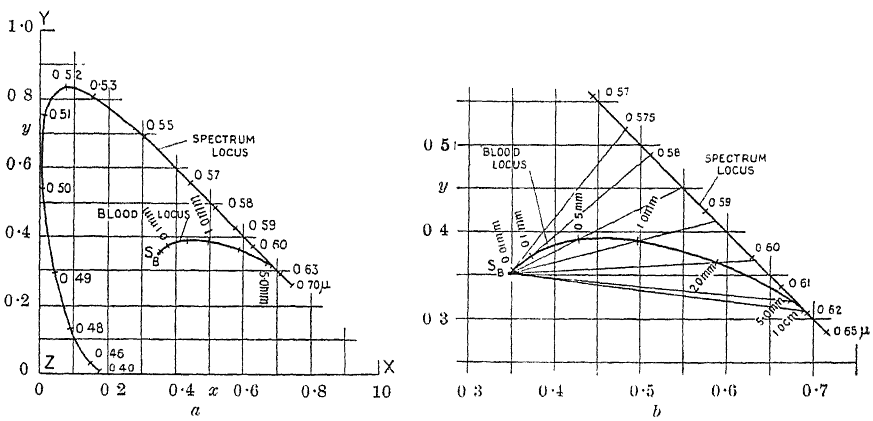


Fig. 3 (a) THE C.I.E CHROMATICITY CHART SHOWING THE SPECTRUM LOCUS, THE WHITE POINT S_B AND THE BLOOD LOCUS (b) AN ENLARGED SECTION OF THE CHART SHOWING THE BLOOD LOCUS AND PART OF THE SPECTRUM LOCUS. WAVE-LENGTHS ARE INDICATED AGAINST THE SPECTRUM LOCUS AND THE THICKNESS OF THE HÆMOGLOBIN LAYERS AGAINST THE BLOOD LOCUS.

This diagram is illustrated in Fig. 3, *a*. The values of x and y are recorded along the horizontal and vertical axes respectively, and the co-ordinates (x, y) of any point in the diagram provide a unique definition of a colour. (The third co-ordinate, z, is given by $z = 1 - x - y$.) The diagram is thus in the nature of a colour chart, but it also embodies the facts of colour mixture; for example, the result of mixing any two colours as defined by their positions on the chart is to produce a third colour located on the straight line joining the two colours being mixed. The locus of the spectrum colours in the chart is illustrated, as well as the position of the white point S_B. When a colour is represented by a point lying close to the spectrum locus, then it means that it is highly saturated with a hue similar to the monochromatic radiation to which it is a neighbour, but as it approaches S_B, so the hue becomes less pronounced and the colour becomes more desaturated.

We can now deduce the changes which take place in the colour of the blood layers. The points for each of the seven layers of Fig. 2 have been plotted in Fig. 3 to give the blood locus in the chromaticity diagram, a locus which starts near to the radiation $0 \cdot 62\ \mu$ and terminates, for extremely thin layers, at S_B. The locus is shown enlarged in Fig. 3, *b*. If straight lines are drawn from S_B through the points representing each layer and extended to intersect the spectrum locus, the points of intersection will give the dominant wave-length of each layer, that is, the wave-length of the monochromatic radiation which, when mixed in a suitable proportion with S_B, would match the colour of the layer. It is seen that the dominant wave-length ranges from $0 \cdot 62\ \mu$, an orange red, to $0 \cdot 575\ \mu$, a yellow, and we thus arrive at the numerical evidence for the change of hue which we deduced from general considerations from Fig. 2. If there had been no change in dominant wave-length with thickness, the blood locus would have been a straight line from the region of $0 \cdot 62\ \mu$ to S_B.

For a proper understanding of each case of dichroism, this type of colorimetric analysis is necessary. The case of hæmoglobin has been used as an example, but it could be applied equally well to those cases quoted, for example, by Paterson[9] or by Baker[1] and Webb[3], and to the changes occurring when coloured samples are viewed under different illuminations. Practically all absorbing media are to some extent dichroic in the sense that the colours of different layers do not lie exactly on a straight line when plotted in the chromaticity diagram, but in many cases the departure from linearity is too small to attract attention by any noticeable change in hue. On the other hand, there are many media, such as malachite green or quinoline blue, in which the change of hue is even greater than that of blood.

There remains one final consideration. The specification of a colour on the trichromatic system is a physical specification of the colour in the sense that it defines the mixture of three stimuli required to produce the same colour sensation as the test stimulus; no claim is made, or could be made, that it measures the sensation itself. While we can, from its position in the chromaticity diagram, state that a colour may be red or green or white, as the case may be, or, when comparing two colours, decide that one is yellower than the other, or more desaturated, and so on, we cannot give any precise description of the appearance of the colour under any given observing conditions, except to say that the three stimuli mixed in the correct proportions would have the same appearance under the same conditions. The appearance itself will be determined by a number of factors, such as the adaptation level and the conditions of contrast; thus when the intensity of a beam of light such as a spectral red or spectral green radiation is increased, the quality of the light appears to change in the direction of becoming whiter. These changes are due to adaptive processes in the retina and possibly in the brain, and they may lead to subtle effects which are by no means easy to evaluate.

Quite recently, however, Newhall, Nickerson and Judd[10] have studied these changes in connexion with an investigation of the spacing of the patterns in the "Munsell Book of Colour". They show, for example, that the 'constant-hue' locus in the chromaticity chart for patterns of decreasing saturation is not in general a straight line from the spectrum locus to the white point, but is a curved path, the shape of which varies from one region of the chart to another. This means that constancy of dominant wave-length does not necessarily imply exact constancy in the hue which an object appears to have. In the red corner of the chart it happens that the constant-hue locus has the same type of curvature as the blood locus, and thus tends to compensate to a small extent for the changes due to the physical dichroism of hæmoglobin, but for

other media the subjective dichroism, if that is an apt description of the phenomenon, may be equally liable to accentuate the change in hue.

[1] Baker, J. R., NATURE, 152, 331 (1943)
[2] Bowen, E. J., NATURE, 152, 476 (1943)
[3] Webb, D. A., NATURE, 152, 476 (1943)
[4] Heilmeyer, L., trans. Jordan, A., and Tippell, T. L., "Spectrophotometry in Medicine" (Adam Hilger, Ltd, 1943).
[5] Commission Internationale de l'Eclairage. Compte Rendu (Cambridge, 1931).
[6] Smith, T., and Guild, J., *Trans. Opt. Soc.*, 33, 73 (1931).
[7] Judd, D. B., *J. Opt. Soc. Amer.*, 23, 359 (1933).
[8] Hardy, A. C., "Handbook of Colorimetry" (Mass. Inst Tech, 1936).
[9] Paterson, D., "Textile Colour Mixing" (Benn, 1927).
[10] Newhall, S. M., Nickerson, D., and Judd, D B., *J. Opt. Soc Amer.*, 33, 385 (1943).

U.S. NATIONAL PATENT PLANNING COMMISSION

By Sir WILLIAM JARRATT

DURING the past few years there has been considerable criticism of the patent system both in Great Britain and in the United States, and the impact of war has tended to intensify it in both countries. In America the criticism has been much more violent than in Great Britain, and many Bills dealing with alleged abuses in the patent system have been introduced in Congress, though none has become law. In view of this acute criticism, President Roosevelt, by Executive Order in December 1941, established a National Patent Planning Commission authorized, in conjunction with the Department of Commerce, to conduct a comprehensive survey and study of the American patent system, and consider whether the system provides the maximum service in stimulating the inventive genius of the American people in evolving inventions and in furthering their prompt utilization for the public good; whether the American patent system should perform a more active function in inventive development; whether there are obstructions in the existing system of patent laws and, if so, how they can be eliminated; to what extent the Government should go in stimulating inventive effort in normal times; and what methods or plans might be developed to promote inventions and discoveries which will increase commerce, provide employment, and fully utilize expanded defence industrial facilities during normal times.

The first report of the Commission, which has now been published (U.S. Superintendent of Documents, Washington, D.C.) is confined generally to the mechanics of patent law, and the use of patents. In an introductory statement, the Commission points out that the strongest industrial nations have the most effective patent systems, and it expresses the opinion that the American patent system is the best in the world. It recommends, however, that the system should be adjusted to meet existing conditions without destroying its basic principles, and it makes numerous specific recommendations for amendment of the patent law of the United States.

Two questions connected with the patent law but of general interest were also considered by the Commission, namely, "Patents and the War Effort" and the "Protection of the Public Interest". On the first question the report states that specific inquiries addressed particularly to representatives of the War and Naval Departments failed to develop any serious instances in which the patent system had interfered with the prosecution of the War. The Commission expresses the opinion that the outcome of the present War, more than any previous war, will depend upon a continuous superiority in science and invention, and that "never before has there been such a free exchange of scientific and technological knowledge and products of invention between our industrial concerns, our research laboratories, and our Government, and between our Government and our Allies. Such a liberal and complete exchange of scientific information and the secrets of industrial laboratories could not have been possible without the reassurance of the protection afforded by the patent system. The American people should recognize the part the system is thus playing in the free exchange of scientific information which is proving so effective in the prosecution of the war and which is so essential to ultimate victory." It is pointed out in the report that the existing law permits the American Government and its contractors to manufacture and use any patented or unpatented invention on payment of reasonable compensation, and the evidence taken by the Commission indicates that the law is adequate to protect the Government during the present national crisis. The British Government has, of course, similar powers conferred on it, and is given similar protection, by Section 29 of the Patents and Designs Acts, 1907 to 1942, which enacts the right of the Crown to use patented inventions and sets out the procedure for determination of the royalty or other compensation payable.

The Commission considered the question of the protection of the public interest from many points of view, the most important being whether it would be in the public interest to incorporate in the law a general compulsory licensing system, that is, a system under which every patentee can be compelled to allow his invention to be manufactured or used by another person on payment of a royalty or other compensation. It was felt that such a system would affect American needs adversely and would produce detrimental effects in foreign countries; and in consequence the conclusion is reached that it would not be advantageous to incorporate a compulsory licensing system in American patent law. The Commission was, however, impressed with the need of a degree of compulsion in certain fields, such as national defence, public health, and public safety, and it recommends in respect of these cases a system whereby in an action for infringement "the recovery of a patent owner shall be limited to reasonable compensation without prohibiting the use of the patented invention". It is interesting to note that this recommendation of the Commission would bring the American law into closer agreement with Section 38 A of the Patents and Designs Acts, 1907–42, of Great Britain, which enacts that, in the case of any patent for an invention for the preparation or production of food or medicine, the Comptroller of Patents shall, unless he sees good reason to the contrary, grant to any person a licence to use the invention, and in settling the royalty or other compensation payable, the Comptroller shall have regard to the desirability of making the food or medicine available to the public at the lowest possible price consistent with giving to the inventor due reward for the research leading to the invention.

On the general question of patents, the American people and their Government are urged by the Commission to recognize the fundamental rightness and fairness of protecting the creations of its inventors by the patent grant, and the Report states that the American patent system has: (1) encouraged and

rewarded inventiveness and creativeness, producing new products and processes which have placed the United States far ahead of other countries in the field of scientific and technological endeavour; (2) stimulated American inventors to originate a major portion of the important industrial and basic inventions of the past hundred and fifty years; (3) facilitated the rapid development and general application of new discoveries in the United States to an extent exceeding that of any other country; (4) contributed to the achievement of the highest standard of living that any nation has ever enjoyed; (5) stimulated creation and development of products and processes necessary to arm the nation and to wage successful war; (6) contributed to the improvement of the public health and the public safety; and (7) operated to protect the individual and small business concerns during the formative period of a new enterprise.

In view of a report so favourable to the present American patent system, it is of interest to note that the numerous important technical changes recommended by the Commission are almost uniformly of such a nature as to bring the American patent system more closely into accord with that of Great Britain.

TRICOTYLEDONY

By H. E. HOLTORP

TRICOTYLEDONY is well known as a sporadic occurrence in dicotyledonous plants, but it has apparently been treated in the past as a rare and somewhat trivial abnormality. I have been unable to trace any evidence of its being regarded as heritable.

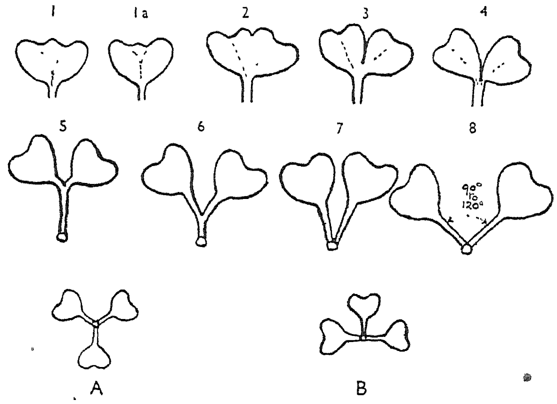
During the last few years I have collected tricotyledonous seedlings from a number of plants, the more important including various brassicas, wallflowers, *Dianthus sinensis*, carnations and carrots. These are mainly biennials, but I have also observed tricotyledony in certain annual dicotyledonous weeds and have more recently secured tricotyledonous tomatoes.

The observations, which I shall describe, have been made chiefly on brassicas (cabbage, savoy, cauliflower), for here the cotyledons are distinct in shape, substance and structure from the true leaves, even to casual inspection. This advantage is shared by tomatoes and carrots, but my investigations with these plants have not yet progressed so far.

I grew the first few tricotyledonous brassicas (generation P) to seed, isolated from other brassicas though not from one another. This seed yielded a considerable number of tricotyls in the S_1 generation. They were not counted, but there is no doubt that the proportion was higher than in the P generation. From this S_1 I selected seventeen of the most symmetrical tricotyls and again seeded them under similar conditions. The next generation (S_2) contained not only some hundreds of tricotyls, but also eighty tetracotyls—a form of which I had not seen a single example in thousands of brassica seedlings before this generation. Again I have selected and planted, in separate groups, the best tricotyls and tetracotyls for an S_3 generation in 1944.

It is thus clear that tricotyledony is a heritable character and one which can easily be changed by selection. Dicotyledony must then be adaptive and maintained by natural selection.

Pleiocotyls are not alike in form, and are not all to be traced to the same kind of variation in the seedling



structure. Seedlings must be grown to a considerable size before adequate description and classification are possible.

In brassicas I have recorded three main types of tricotyledony, each subject to its own characteristic variation, under the headings: (*a*) *simple fission*, (*b*) *twinning*, complete and incomplete, and (*c*) *supplementation*.

Fission. This appears as simple splitting of a cotyledon, from the notch in the terminal edge along the central vein towards the petiole. The split varies in length, the most extreme case seen being one of two elliptical pieces of tissue with separate stalks joined to form one petiole. Seedlings in this class are viable and grow into healthy plants, but the split cotyledon is always distorted and lags behind its normal fellow in growth.

Twinning. The diagram represents various forms of twin cotyledons and their petioles as found, together with all intermediate forms, in the brassicas. The simplest form (1) is a two-notched broad cotyledon in which the central peak is quite commonly not prominent (1*a*). The mid-vein is noticeably forked. This form is very common and is the only one which (except for true tetracotyls) occurs often in both cotyledons of a seedling. The remaining types are not infrequent though the symmetrical tricotyl (*A*) is somewhat rare, just as is a perfectly symmetrical dicotyl.

Supplementation. This variant has been quite common in the progeny of tricotyls after selection. Three main classes have been distinguished.

(1) The seedling is apparently normal and dicotyledonous, but the first subsequent true leaf, instead of being of the characteristic rough type, develops as a third cotyledon identifiable by substance, structure, venation and petiole, and even, in many cases, by its shape. It is, however, never a normal cotyledon, for its shape never changes by growth once it has developed. It grows but little after development, unlike the normal true leaf. This third cotyledon replacing the first true leaf may be (*a*) nearly but not quite a normal cotyledon, (*b*) clearly cotyledonous but incomplete, varying from the major portion of a cotyledon down to little more than the central vein, (*c*) clearly cotyledonous but with one lower quadrant, or perhaps a little more, showing a serrated edge like a true leaf, or (*d*) rarely, with about one half cotyledonous and the other more like a true leaf.

(2) The third cotyledon appears in rare cases in place of the second true leaf, after a first normal true leaf has been produced. It may even appear in place of the fourth leaf after three true leaves. Though

definitely cotyledonous, these were deformed and incomplete. In the case where the cotyledon replaced the fourth leaf, it consisted of a petiole about 3 in. long, bearing a relatively small lamina split down the centre with the two halves divergent.

(3) The third cotyledon is occasionally borne opposite the first true leaf at one node instead of being at a separate node.

Seedlings showing supplementation grow well into good plants. In general, however, fission and supplementation do lead to local malformation, though twinning does not.

Tricotyledonous brassica plants sometimes bear a pair of true leaves at the first node, or the first or second leaf may be incompletely twinned. Similarly in the wallflower, carnation and *Dianthus sinensis*, tricotyledony is often accompanied by the occurrence of three true leaves at the first, and sometimes also at the second, node.

Thus pleiocotyledony in brassicas occurs, as I find it, in several forms, counts of which should be made in the progeny of each type of tricotyledonous parent for the various forms can all be found among the offspring of one plant. I have estimated that the S_2 generation contained 25 per cent pleiocotyls of one kind or another, and a similar percentage has been found in a small test with the tomato. Pleiocotyly in an S_2 of wallflower, however, is as high as 40 per cent. Full analysis, however, involves growing all the seedlings to a size hitherto impossible in the conditions under which I have worked. I hope to obtain improved facilities in the future and so to obtain adequate counts in the selection lines.

I am indebted to Dr. K. Mather, of the John Innes Horticultural Institution, for advice on the interpretation of these observations.

SCIENTIFIC CENTENARIES IN 1944

By ENG.-CAPT. EDGAR C. SMITH, O.B.E., R.N.

AMONG the many men of science whose centenaries occur this year are representatives of England, Scotland, Ireland, France, Belgium, Sweden, Italy, Austria and America. Four hundred years ago, according to Silvanus Thompson, Gilbert was born; three hundred years ago, Castelli, Gascoygne and van Helmont died and Römer was born; two hundred years ago Celsius and Desaguliers died and Lamarck and Mechain were born, while among those who died a century ago were Dalton, Baily, Hope, Henderson and Geoffroy Saint-Hilaire.

On December 10, 1903, the exact tercentenary of the death of William Gilbert was commemorated by a meeting of the Institution of Electrical Engineers held at the Institution of Civil Engineers, at which the Royal Society, the Royal College of Physicians, St. John's College, Cambridge, the cities of Colchester and Westminster and the Société Internationale des Electriciens were represented. The address was given by Silvanus Thompson, who said "that electricians owed an enormous debt of gratitude to Gilbert, who, for them, was pre-eminent among all the great men of Elizabeth's time". The occasion was marked by the presentation to the City of Colchester of a picture representing Gilbert showing his experiments to Queen Elizabeth and her Court. The tomb of Gilbert in Holy Trinity Church, Colchester, gives the year of his birth as 1540, but Silvanus Thompson considered the correct date to be May 24, 1544.

Van Helmont (1577–1644), like Gilbert, was a physician, and for a short time filled a chair at Louvain; but his life was spent in philosophical studies and he was the first to recognize the existence of various aeriform substances to which he gave the name 'gases'. He was born in Brussels but died in Holland. Benedict Castelli (1577–1644) was an exact contemporary of van Helmont, and had the privilege of being taught by, and assisting, Galileo; he held chairs both at Pisa and Rome. William Gascoygne (1612 ?–1644), the inventor of the micrometer and a correspondent of Horrocks and Crabtree, died at about the age of thirty, fighting on the Royalist side at Marston Moor on July 2, 1644. Olaf Römer, the Danish astronomer, was born at Aarhuus, in Jutland, on September 25, 1644, and died at Copenhagen on September 19, 1710. His discovery of the velocity of light was made in Paris, when he was thirty-one; his famous transit instrument was made at Copenhagen, where he held the chair of astronomy. Many of his manuscripts were destroyed in the Copenhagen fire of 1728. The year 1744 saw the death of both Andreas Celsius and John Theophilus Desaguliers. Celsius was born at Uppsala on November 27, 1701. His travels took him to Germany, Italy and France, and then he went to Lapland with Maupertuis to measure an arc of the meridian. According to Cajori, Celsius marked his centigrade thermometer with boiling point as 0° and freezing point as 100°, and it was his colleague Märten Stromer who inverted the scale. Desaguliers was nearly twenty years senior to Celsius, having been born at Rochelle on March 12, 1683. He was brought to England by his father, a Calvinist pastor who left France on the Revocation of the Edict of Nantes. The child, it is said, was smuggled aboard the refugee ship in a barrel. France's loss was England's gain, for Desaguliers succeeded Keill as a lecturer on experimental philosophy at Oxford, and then in 1713 began his work in London "where," he wrote, "I have with great pleasure seen the Newtonian Philosophy so generally received among persons of all Ranks and professions, and even the Ladies by the help of experiments". At his death, Desaguliers was buried in the Savoy. Of the two Frenchmen, Lamarck and Mechain, the former was born in the village of Bazentin (Somme) and the latter at Laon (Aisne). Lamarck began life as a soldier, and then held a post in a Paris bank. In 1774 he became a keeper in the Jardin des Plantes, and there, for a quarter of a century, he lectured on invertebrate zoology. He died in 1829, blind and poor. Pierre F. A. Mechain was a geodesist as well as an astronomer and hydrographer, and it was while still employed on the extension of an arc of the meridian to Barcelona that he died on September 20, 1805.

Coming to those who died a hundred years ago, one of the most famous was Étienne Geoffroy Saint-Hilaire, who was born at Etampes on April 15, 1772, and who did great work both for the Jardin des Plantes and the Museum. In Scotland, few were better known than Thomas Henderson (1798–1844) and Thomas Charles Hope (1766–1844). Henderson, a native of Dundee, began life as a lawyer's clerk, but his studies led him to become acquainted with Wallace and Leslie, and through his papers he gained recognition as an astronomer. After a year or two at the Cape of Good Hope, on October 1, 1834, he became the first Astronomer Royal for Scotland. His contemporary, Hope, was always a chemist, and from 1799 until 1843 occupied the chair of chemistry in

the University of Edinburgh, previously held by Black. To him we owe the discovery of the maximum density of water. The centenary of John Dalton falls on July 27 of this year, but any commemoration must inevitably be clouded over by the results of the air raid of December 24, 1940, when the premises of the Manchester Literary and Philosophical Society were completely destroyed. From 1817 until 1844 Dalton was president of the Society, and within its walls he taught, lectured and experimented. The Society had an unequalled collection of his apparatus, but after digging among the ruins the only things found were his gold watch, a spark eudiometer and some charred remains of letters and note-books. A month after Dalton passed away in Manchester, Francis Baily died in London, after a life devoted to astronomy and kindred subjects. "Few men have left behind them so enviable a reputation. He was gentle as well as just; he loved and sought truth; he inspired in an equal degree respect and affection."

As is usual in these annual reviews of the centenaries of men of science, names of notable men born a century ago crowd closely upon one another, but it will perhaps be agreed that all those mentioned below have claims to recognition. Among the ranks of the physicists born in 1844 were Sir William F. Barrett (died 1925), who for more than thirty years held a chair in the Royal College of Science, Dublin; Sir William Abney (died 1921), who did much to put photography upon a scientific basis; and Ludwig Boltzmann (died 1906), professor of mathematical physics in the University of Vienna. Boltzmann died a tragic death, and his successor, F. Hasenöhrl, was killed in action on the Italian front in 1915. The chemists born in 1844 include Prof. J. Emerson Reynolds (died 1920), who occupied for twenty-eight years the chair of chemistry in the University of Dublin, and Ferdinand Hurter (died 1898), a native of Schaffhausen, Switzerland, who came to England in 1867 and became principal chemist to the United Alkali Company. Among astronomers, Prof. W. R. Brooks (died 1921) of the United States was famous as a 'comet hunter'. Charles Trépied (died 1907) was for many years director of the Observatory at Bouzariah, eleven kilometres from Algiers, while Annibale Ricco (died 1919), though he began life as an engineer, for nineteen years directed the observatory of Catania and Etna, his special subject being solar physics. In another sphere of scientific activity, Henry Alleyue Nicholson (died 1899) held professorships at St. Andrews and Aberdeen, and was Lyell medallist in 1888, while Auguste Michel-Lévy (died 1911) was director of the Geological Survey of France. A notice of the life and work of Michel-Lévy was read at a sitting of the Paris Academy of Sciences on December 21, 1914, under the shadow of war. The opening sentences ran, "Aux heures les plus graves de notre histoire nationale, l'Académie des Sciences a toujours tenu à proclamer bien haut sa foi inébranlable dans les destinées de la Patrie en n'interrompant en rien l'ordre régulier de ses travaux. C'est pourquoi, alors que notre territoire est encore envahi par l'ennemi, l'un de vos Secrétaires perpétuels vient, comme de coutume, vous rappeler en cette séance annuelle le souvenir de l'un de nos confrères disparus."

OBITUARIES

Sir Edward Poulton, F.R.S.

EDWARD BAGNALL POULTON, who died on November 20, was born on January 27, 1856. His school life was spent at Oakley House, Reading, until he was nearly seventeen, when he commenced work in the office of his father, who was an architect. His interest, however, was so obviously in science that he was allowed to work for a scholarship, attending Rolleston's lectures at Oxford. He obtained an open scholarship in science at Jesus College in 1873, and after a crowded three years took a first class in the honour school of natural science. Next year he was appointed demonstrator in zoology under Rolleston, whose virile personality greatly impressed him. But working as one of his staff under him was a very different thing from being one of his students, and Poulton could do little research. During the long vacation, however, he was inspired by Foster and Balfour's work on embryology to follow their methods, and as a result was given a class to teach in that subject. His income being inadequate, he studied for a University scholarship in geology under Prestwich, eventually obtaining the Burdett-Coutts Scholarship. Thus it came about that, having resigned his demonstratorship, his first research was conducted on a geological subject, and his first paper was published in 1880 on remains in quaternary sands at Reading.

Rolleston was succeeded by Moseley in 1881 and Poulton, by now lecturer at Keble and Jesus Colleges, found him as helpful as Rolleston had been difficult. Moseley suggested that he should investigate some *Challenger* material, and as a result of his studies three papers were published in 1883 on the tongues of several Australian animals, including Ornithorhynchus. An investigation of the structure of the hair of this primitive creature then followed, sections of the head of an immature specimen having been lent by Dr. W. K. Parker. This resulted in a discovery of fundamental importance, for Poulton announced in 1888 that Ornithorhynchus possesses true teeth which cut through the gums but are replaced by horny plates.

But although he was professionally occupied with morphology, Poulton's real interest was in living insects. Such entomological studies as he saw being conducted by Westwood at Oxford did not, however, appeal to him, for they were concerned mainly with systematics. Poulton had read Wallace's essays on natural selection in 1878, and these aroused what he described as "a lifelong delight" in the subject of the coloration of animals, particularly of insects. Weismann's studies in the theory of descent, of which he read in 1883 a translation by his friend R. Meldola, contained an account of variation in the colour of a caterpillar according to its surroundings, which especially interested Poulton, as it recalled observations he had made in boyhood upon that very species.

He began to work at once on that subject, and, amidst his morphological work, produced during 1884–88 a succession of papers on the colours of larvæ and pupæ and on experiments to test the factors influencing them, and their survival value. These researches led to his election to the Royal Society in 1889, and in 1890 his great work "The Colours of Animals" at once set him in the front

rank of upholders of natural selection, and until recently held the field as a comprehensive guide to the meaning of all forms of coloration. He became known as an ardent champion of pure Darwinism, finding in it a satisfying explanation of countless phenomena of colour and habits which, he always emphasized, must be studied and explained together. He first read "The Origin of Species" in 1875 as an undergraduate, and throughout his life it was almost like a Bible to him. He explained, in two books, the principles on which it was based, to aid those who, perhaps, felt the masterpiece rather too much for them.

The extravagant claims of the early mutationists particularly distressed Poulton, and he fought against the idea which Sir Oliver Lodge neatly expressed at the British Association in 1913—that not only is it untrue to say '*Natura non fecit saltum*' but that it is doubtful if she ever does anything else. Partly, perhaps, for this reason and partly because mathematics were as incomprehensible to him as to the master he served, he was never attracted by genetics, though heredity greatly interested him, and he took much interest in eugenics.

The death of Westwood left vacant the recently founded chair of Hope professor of zoology at Oxford, and Poulton was elected to it in 1893: there could scarcely have been a greater change. Westwood had been mainly occupied in the prevalent mode of adding to knowledge by describing new species and classifying them. In this he won world renown, but he did not move with the times, and warned Poulton against the dangers of the new doctrine. It was an irony that the young man so warned became one of its most forceful exponents. One of the first applications of Darwinism to problems of field natural history was the theory of mimicry, propounded by Bates in 1862, which explained the deceptive, superficial resemblance of one species of butterfly to another better protected by unpleasant qualities against the attacks of predators. Mimicry became one of Poulton's chief subjects, and all that he and his friends did to make known the extent of the phenomena convinced him that no explanation covers all the facts so well as natural selection. Critics have not always troubled to understand thoroughly the problems involved in mimicry, and it is a pity that the logical terms which Sidgwick devised for Poulton ("pseudaposematic" and "synaposematic") are not more generally used. If these types of coloration are due to selective preferences of predators, then upholders of the theory must produce evidence, and Poulton continually urged naturalists to observe and experiment in the field. A large body of facts has thus been accumulated, but it is not unfair to say that Poulton was not statistically minded; and most of the records, while adding more and more instances of observed cases, are not satisfying to the inquirer into "*How much* better ?" or "*How much* more often ?"

It was one of Poulton's correspondents who first showed that, when a bird attacks a butterfly and releases it, the shape of the bill is recognizably imprinted upon the wing, and much work on this subject has been done which goes to show that birds are probably the selective agents which theory requires for the production of mimicry in butterflies. On the other hand, if vertebrates avoid certain species as relatively distasteful, it is possible that these are destroyed by insect predators, and this point was also urged by Poulton, and evidence shows that this is so.

The importance of the fact that 'edibility' is relative, and merely a function of abundance, is frequently overlooked by critics. This point was emphasized by Poulton. The value of mimicry closely depends upon geographical distribution, and studies made by Poulton and his associates have shown that in such remarkable polymorphic species as *Papilio dardanus* and *Pseudacraea eurytus*, the prevailing form of the mimetic species corresponds numerically with the species of model most abundant in the locality. Moreover, if the protective influence of a model is removed by its decline in numbers, or by the mimetic species occurring in localities from which models are absent, the mimic is uncontrolled by selection and the mimetic resemblance deteriorates.

A Darwinian may be expected to show interest in sexual selection, and Poulton's influence resulted in important discoveries of structures used to produce scent in courtship, and of habits displaying special colours before the female. The extraordinary behaviour of certain male flies (Empididae), closely studied by one of his assistants, was shown to constitute a complete evolutionary series in the development of an elaborate courtship.

All this involved immense labour in correspondence, but there was also the care of the great collections which grew embarrassingly, so that it became beyond his power to attend to every detail himself, and he was very insistent upon detail; thus to anyone but Poulton himself there seemed to be considerable confusion. He paid particular attention to making a label tell the whole story of a specimen, so that Hope Department labels are recognized to be the most informative in any collection in the world. But his passion for making the title of a communication summarize all the contents often proves a trial to bibliographers.

After his retirement in 1933, Poulton's friends hoped that, freed from the care of the department which he had made renowned, Poulton would settle down to the production of his *magnum opus*, but this was not to be. He was unable to shake himself free from the toils of correspondence; his powers weakened, his memory began to fail, and kindly death took him peacefully while he was still happy and interested.

His distinctions were many. He served on the Council of the Royal Society during 1897–99 and 1908–10; was vice-president during 1909–10 and Darwin medallist in 1914. He presided over the Linnean Society during 1912–16 and was Linnean medallist in 1922. When the second International Entomological Congress met at Oxford in 1912, he was its president; in 1915 he gave the Romanes Lecture. He thrice presided over the Entomological Society, the last occasion being at the centenary meeting in 1933, at which it became a Royal Society. Several universities, at home or abroad, conferred honorary doctorates upon him, and he was an honorary member or correspondent of many learned societies.

Friendly, affectionate and uncompromisingly truthful, he was a great believer in intercourse and a habitual attendant at the British Association meetings, at which he presided in 1937 and with which he went to South Africa and Australia. He also visited North America, and everywhere established links of closest friendship. He married in 1881 Emily, daughter of George Palmer, formerly M.P. for Reading, who predeceased him. They had two sons and three daughters, of whom only Mrs. Maxwell Garnett

survives him. There are thirteen grandchildren and three great-grandchildren to carry on his memory.

By the death of Sir Edward Poulton, natural history, as Darwin taught it, has lost a master. He will long be remembered for his life's work at Oxford; from it has flowed inspiration and help to naturalists seeking truth all over the world. They found him a never-failing counsellor and a generous friend whom they learnt to love. G. D. HALE CARPENTER.

Mr. H. F. Witherby, M.B.E.

THE death of H. F. Witherby on December 11 leaves a gap in the students of British ornithology which will be difficult to replace. He was the second surviving son of Henry Forbes Witherby of Burley, Hants, and was born on October 7, 1873. After leaving school he entered the old family publishing firm of Witherby and Co., and some years ago retired, but resumed work again after the outbreak of war.

Although a successful business man, the study of birds was Witherby's main interest in life, and for this purpose he made many trips abroad in search of birds. He was specially interested in Spanish ornithology, and contributed several papers on this subject to the *Ibis*. Early in his career Witherby became interested in migration, and with the object of studying this phenomena visited many well-known localities on the east coast, and in 1938 even venturing to Fair Isle.

In 1909 he started the 'British Birds' ringing scheme, which from a small beginning has grown to be of national importance and is now carried on from the British Museum under the auspices of the British Trust for Ornithology. In 1907 he founded *British Birds* magazine, and this soon brought him in touch with all those interested in the study of birds in these islands. With the help of others he published a "Handlist of British Birds" in 1912, and in 1912–24, with the assistance of other ornithologists, a "Practical Handbook of British Birds". When these volumes became out of print he published during 1938–41 a more ambitious work, the "Handbook of British Birds", in five volumes; this has rightly been described as the best book on the birds of any country. Witherby himself was responsible for the systematic work and general editorship.

He had a very fine collection of both British and European birds which he sold to the British Museum, giving the proceeds to the British Trust for Ornithology, a body he took great interest in from the beginning. His collection was very carefully made, mainly for the purpose of studying races and plumages. Together with the late Dr. C. B. Ticehurst he did much to elucidate the moults and sequence of plumage of our native birds—indeed it might be said of European species also. It was Witherby who cleared up the long-disputed question as to how the rook developed its bare face, and in an article in *British Birds* proved it was a matter of age, not wear. Witherby was a very careful and painstaking worker, and would take an enormous amount of trouble before admitting a new species to the British list, or a record of a rare visitor. The late Dr. Hartert may be said to have introduced the trinomial system into ornithology in Great Britain, and Witherby was one of the first to appreciate the importance of this step.

As editor of *British Birds*, Witherby occupied a unique position in the study of our native birds, and he will be sadly missed by his many friends and correspondents; to beginners he was especially helpful and encouraging. During 1924–27 he was chairman of the British Ornithologists' Club, and president of the British Ornithologists' Union during 1933–38. On his retirement he was awarded the Godman-Salvin Medal for his work on ornithology.

In 1904 he married Lilian, daughter of the Rev. S. Gillson, and leaves two sons and three daughters.

N. B. KINNEAR.

NEWS and VIEWS

Secondary Education in Great Britain

THE valuable statement "The Open Door in Secondary Education", issued by the members of the Education Sub-Committee of Nuffield College Social Reconstruction Survey, does full justice to the twin aims of educational reform: maintenance of the quality of the education provided, while making sure that opportunities at present the privilege of a minority become the heritage of the nation. Its six recommendations are accompanied by a brief survey which indicates the rapidity with which opinion has advanced in this field. First, the Statement recommends that in all schools which receive any grants from the State or from local education authorities, tuition should be free and adequate maintenance grants should be given. Secondly, the scales on which grants are made to schools should vary according to the education they provide, especially in equipment, staffing ratio and opportunities for advanced work. To deal with the allocation of grants and with the question of control involved in this second recommendation, establishment by the Board of Education of a school grants central committee on the lines of the University Grants Committee is proposed, assisted by a small number of regional committees.

All schools for children between the ages of eleven and eighteen should be inspected by the Board of Education at intervals of not more than five years. All private schools which have not yet been formally recognized should be required to obtain from the Board a certificate of efficiency: but no school should be closed by the Board of Education without the right of appeal to an independent tribunal. One member of the Committee, Sir Richard Livingstone, regards this proposal as too drastic and open to abuse, and would tackle the evil of the undesirable school by giving a certificate to schools which submit to voluntary inspection and are approved, or by refusing anyone leave to teach who does not hold a university degree or has not attended an approved course for training in teaching.

The Statement then recommends that the school grants committee and the local education authorities should be empowered to make grants to children to enable them to pass from schools under their jurisdiction to independent private schools if they secure places in them. Maximum grants should be fixed by the school grants committee. Finally, such grants should only be made to children entering schools which observe the following conditions to the satisfaction of the Board of Education: (*a*) that to the extent of their normal numbers they admit children

according to their capacity to profit by the education provided, and not according to their parents' needs; (*b*) that the schools provide from their own resources any sums needed above the maximum grants specified to pay the fees for any pupil they admit who may need further assistance; and (*c*) that the schools devise or accept tests of suitability for entry with enough options to enable children who have had different types of early education to show ability to profit by the education given in the schools.

Scientific Men in Government Service

ALTHOUGH the article "Science and Government" by Dr. H. G. Moulton, president of the Brookings Institution (published in *Science* of December 11, 1942, which has just been received), is mainly concerned with relations between scientific workers and the Government of the United States, it is of some interest with regard to current discussions in Great Britain on the place of science in government. Dr. Moulton covers a wide field, including scientific research into the machinery of government as well as the conduct of scientific research by government and the use of scientifically trained men by government, and he suggests that the surest means of resolving the prevailing confusion of our time and of finding solutions to the baffling problems now confronting civilization lies in a re-integration of knowledge through the systematic study of the various fields of science conceived as a whole. This is the primary function of the university, but the failure of the U.S. Government to make more effective use of science in the determination of policy is attributed to shortcomings in the organization of the American system of government and politics. Dr. Moulton points out that while the scientific men in government departments may assemble the data required with true scientific objectivity, they are usually debarred from interpreting the data or formulating conclusions to be drawn therefrom. There is no easy road to efficiency in government. Scientific men, business men and the general public must take an active and continuous interest in government, keeping themselves informed on the issues involved and electing honest, public-spirited and able servants. Public office-holding must be made a high calling, a worthy and rewarding career for anyone, and representatives must be encouraged to think in terms of the national welfare as a whole, rather than in terms of sectional or local interests.

Sugar Research Foundation

DR. ROBERT C. HOCKETT, associate professor of organic chemistry at the Massachusetts Institute of Technology, has been appointed scientific director of the Sugar Research Foundation. Following his graduation from Ohio State University, Dr. Hockett served there as graduate assistant in analytical chemistry. As a fellow of the National Research Council, he went to the National Institute of Health, United States Public Health Service, where he worked with Dr. C. S. Hudson. Dr. Hockett later became associate technologist of the Institute of Health and served in that position for several years. Since 1935, Dr. Hockett has been at the Massachusetts Institute of Technology, where he has developed a research programme on the chemistry of carbohydrates. Mr. Joseph F. Abbott, president of the Sugar Research Foundation, said that this appointment is the first step in a new scientific programme to extend knowledge of the role of sugar and other carbohydrates in the human body and also of the chemical transformations to which sugars can be subjected. It is anticipated that such chemical studies, both fundamental and applied, will eventually indicate new industrial uses of sugar and its derivatives. Dr. Hockett has been granted five years leave of absence from the Massachusetts Institute of Technology to carry on his new work with the Foundation.

Mr. Abbott pointed out that the aims of the Sugar Research Foundation, which is a non-profit organization with offices at 99 Wall Street, New York 5, N.Y., and was formed last June, include the promotion of research and scientific studies at universities and other research institutions on the uses of sugar, and the dissemination of accurate information concerning sugar. It is supported by cane sugar refiners and beet sugar processors, as well as raw sugar producers of Hawaii, Louisiana and Puerto Rico. It is believed that research on the proper balance between carbohydrates and other food elements in the diet will do much to aid the public in utilizing intelligently low-cost energy foods, such as sugar. This will be of obvious importance during the present period of world-wide food shortages, and for some time after the cessation of hostilities, when populations will have to be fed on diets containing a high proportion of sugars and other carbohydrates.

Development Advisor for West Africa

THE Secretary of State for the Colonies has appointed Mr. N. F. Hall, director of the National Institute for Economic and Social Research, to be development advisor for West Africa. He will be on the staff of the Resident Minister and will act in close consultation with the Governments of Nigeria, the Gold Coast, Sierra Leone and the Gambia, which have been working for some time on plans for post-war development. Mr. Hall has been on leave of absence from the National Institute since 1938 for war duties, and has served as joint-director of the Ministry of Economic Warfare; and more recently has been in charge of economic warfare work at the British Embassy, Washington, where he held the rank of Minister in the Diplomatic Service.

Mr. Maxwell Fry has been appointed town-planning advisor to the West African Governments; he will assist in the preparation of schemes for the large-scale housing and town-planning which is contemplated by these Governments.

Welsh Secretary of the Ministry of Agriculture

MR. J. MORGAN JONES, registrar of the University College of Wales, Aberystwyth, has been appointed Welsh Secretary of the Ministry of Agriculture in succession to Dr. C. Bryner Jones as from March 31, 1944. Mr. Morgan Jones is the son of a Montgomeryshire farmer, and a former student of the University College of Wales, Aberystwyth. In 1924 he joined the staff of the newly established Advisory Department in Agricultural Economics of the College and remained as a member of Prof. A. W. Ashby's staff until 1930. In that year he was appointed to the Markets Division of the Ministry of Agriculture. He returned to Aberystwyth at the end of 1935 to become registrar at his old College. During the War he has been closely connected with the food production campaign in Wales in the capacity of Minister's liaison officer for the counties of Cardigan, Pembroke, Carmarthen, Brecon and Radnor, and more recently

also as chairman of the Cardiganshire War Agricultural Executive Committee. Dr. Bryner Jones will continue to act as one of the Minister's liaison officers for Wales.

Veterinary Surgeons and Military Service

A JOINT statement was issued by the Ministry of Labour and National Service and the Ministry of Agriculture and Fisheries on October 5 announcing the setting up of the Army Service Veterinary Selection Committee to advise the Ministers concerned on the recruitment of veterinary surgeons for military service in their professional capacity. In order to provide full representation of the interests of veterinary surgeons in private practice, an additional member representing the National Veterinary Medical Association has been appointed to the Committee. This Committee has considered the cases of veterinary surgeons who have graduated since January 1, 1940, and who at present comprise the 'pool' from which the men needed for service in the R.A.V.C. will be recruited as required. Notifications of the Committee's decisions in these cases are being sent to the assistants concerned and also to their employers. It is expected that the number of veterinary surgeons thus made available to the R.A.V.C. will go some way, at least, to meet immediate needs. It is essential, however, in order to meet urgent military contingencies, to have a reserve of veterinary surgeons who may be drawn upon when necessary. It has accordingly been decided that the 'pool' shall be extended to include all veterinary surgeons born on or after January 1, 1914. The cases of these men will be dealt with on their merits, in accordance with the arrangements set out in the earlier announcement.

Economic Flux Density in Large Transformers

IN a paper read before the Institution of Electrical Engineers in London, D. J. Bolton pointed out that technical developments may at any time make it possible to increase the working densities in electrical machines and so enable a larger output to be obtained from a given frame-size and weight of active materials. The present paper assumes that an increase of transformer flux density is technically feasible, and tries to discover whether it is economically desirable. Only a single situation is examined, and only two, fairly large, sizes of transformer, such as would be used in the lower-voltage sections of the British Grid, are considered. The results are emphatically against any such increase, and in favour of densities lower than those in use at present.

Edible and Poisonous Plants of the Pacific Islands

A SMALL technical manual, prepared by Dr. E. D. Merrill of Harvard University, has been issued by the War Department of the United States, giving descriptions of the "Emergency Food Plants and Poisonous Plants of the Islands of the Pacific" (T.M. 10–420. Superintendent of Documents, U.S. Government Printing Office, Washington, D.C.). Although the manual is intended "to aid the individual who becomes separated from his unit" to sustain himself, it has a wider field of interest. More than a hundred of the more common edible tropical plants are figured, and each is accompanied by a short description with notes as to what parts may be eaten and how they should be prepared, together with a list of the plant names in local tongues. Nearly a dozen of the more virulent poisonous plants are also included. The simple, clear habit drawings are admirable. Occasionally human figures are included to indicate the scale, a practice which, perhaps, might have been followed more often. However, the whole makes an excellent handbook.

The Night Sky in January

FULL moon occurs on Jan. 10d. 10h. 09m. U.T., and new moon on Jan. 25d. 15h. 24m. The following conjunctions with the moon take place: Jan. 6d. 18h., Mars 8° N.; Jan. 8d. 04h., Saturn 2° N.; Jan. 13d. 11h., Jupiter 0·7° S.; Jan. 22d. 21h., Venus 2° S.; Jan. 22d. 23h., Mercury 0·1° S. The following occultations of stars brighter than magnitude 6 take place: Jan. 4d. 16h. 14.6 m. ξ^2 Ceti (*D*); Jan. 8d. 19h. 31·8m., 64 Orio (*D*); Jan. 9d. 00h. 52·5m., 68 Orio (*D*); Jan. 15d. 04h. 15·1m., 308B Leon (*R*); Jan. 16d. 05m. 03·9s., *b* Virg (*R*). The times refer to Greenwich and *D* and *R* refer to disappearance and reappearance respectively. Mercury is in inferior conjunction on Jan. 8. In the middle of the month it rises and sets an hour before the sun, the times at the end of the month being 6h. 27m. and 14h. 29m. Venus, a morning star, rises at 4h. 37m., 5h. 12m., and 5h. 44m. at the beginning, middle and end of the month respectively. Mars, in the constellation of Taurus, is stationary on Jan. 10. The planet can be seen through a great part of the night, being due south at 21h. 30m., 20h. 34m., and 19h. 42m. at the beginning, middle and end of the month, the times of setting on the corresponding dates being 5h. 45m., 4h. 50m., and 4h. Jupiter, in the constellation of Leo, rises at 20h. 07m., 19h. 04m. and 17h. 50m. at the beginning, middle and end of the month and is visible throughout the night. Saturn, in the constellation of Taurus, sets about an hour later than Mars at the beginning and middle of the month, and on Jan. 31 it sets at 4h. 39m. The earth reaches perihelion on Jan. 4, its distance from the sun being then 91,447,000 miles. There will be a total eclipse of the sun on Jan. 25, partly visible as a partial eclipse at Greenwich. The eclipse begins at Greenwich on Jan. 25d. 16h. 29m., but the magnitude of the eclipse will be only about 1/50, and this will occur about sunset. The Quadrantid meteors are due on Jan. 3 and 4; the radiant of this shower is at R.A. 15h. 20m., Dec. + 50°.

Announcements

THE Council of the British Cotton Industry Research Association announces that Dr. F. C. Toy has been appointed to succeed Sir Robert Pickard, who is relinquishing the post of director of research which he has filled for the last seventeen years. Dr. Toy has held the position of deputy director of the Association since he joined the Shirley Institute staff thirteen years ago. Dr. D. W. Hill has been appointed to succeed Dr. Toy as deputy director. Sir Robert Pickard has accepted the post of consultant to the Association.

ERRATUM. In connexion with the paragraph on the Duddell Medal award to Mr. J. Guild in NATURE of December 11, p. 686, reference was made to Mr. Guild's work on the improved goniometric spectrometer in collaboration with "the late Mr. George Watts". We are informed that Mr. Watts is still chairman of Messrs. E. R. Watts and Son, Ltd., and takes an active part in the daily work of the firm's factory.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Structure of Nucleic Acid in the Dividing Cell

RECENTLY Donovan and Woodhouse[1] advanced a speculation on the nature of the chemical structure which is the essence of the malignant cell. Their idea is the formulation of a molecule in the chromosome capable of splitting into two similar symmetrical portions, and this is envisaged specifically as a nucleic acid linked through pyrophosphoric acid to nucleotide groups. It is a moot point whether or not they are justified in regarding nucleic acid as the 'master constituent' to the exclusion of other known nuclear components. In this communication, however, it is desired to emphasize certain points concerning the chemistry of nucleic acids which arise from their communication.

Donovan and Woodhouse suggest that "when engaged in ordinary cellular activities, the cell has, as its essential basis, molecules of nucleic acid joined by pyrophosphoric linkings to nucleotides similar to" co-dehydrogenase I, thiamine pyrophosphate, riboflavine-adenine dinucleotide and phosphagen "which subserve its normal metabolic activity. When cell division is about to take place the metabolic nucleotides on one side of the linkage are replaced by, or are converted into, nucleotides which are the mirror image of those on the primary nucleic acid portion. The symmetrical, double nucleic acid then splits, with resultant division of the chromosomes accompanied by the associated phenomena which comprise 'cell division'. In the case of the malignant cell, however, [they postulate that] the symmetrical development of the dual nucleic-acid molecule proceeds directly and continually instead of via the usual attachment of the metabolic type of nucleotide groups."

The use of the phrase 'mirror image' is unfortunate, since it implies that the new molecule of nucleic acid will be the enantiomorph of the original. This would involve the existence of a molecule of nucleic acid differing profoundly from the original in its stereochemical structure, and as a consequence the two daughter chromosomes would be different, not identical, as is in fact the case in cell mitosis. Further, no nucleic acids containing enantiomorphic sugars have so far been recorded.

The structural diagram given by Donovan and Woodhouse for their proposed double nucleic acid is entirely without experimental basis since, so far as is known, no nucleic acid contains both pentose and desoxypentose sugars in the same molecule. It would, however, have been reasonable to assume that the nucleic acid entering into the cellular reactions postulated would be desoxyribonucleic acid, in view of the claims by Caspersson and others that it is comprised in the chromosomes.

Although it is true that the pyrophosphate group is common to several naturally occurring nucleotides, there is no evidence of its presence in isolated ribo- or desoxyribo-nucleic acids. That does not, of course, exclude the possibility of its occurrence in the living nucleus, but it should be realized that, in the formulation of the double nucleic acid by Donovan and Woodhouse, there are no dissociating groups in the phosphoryl radicles; such groups are generally regarded as participating in the union with the basic protein to form the nucleoprotein.

It is felt that, although simple chemical interpretations of the dividing chromosome and the malignant cell are much to be desired, it is unwise at present to attempt to limit consideration to one cell constituent alone. Furthermore, interpretations must be based on well-established facts, both biological and chemical, and simplification of the problem must not assume such importance that those facts are subordinated to it.

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Nov. 27.

[1] Donovan, H., and Woodhouse, D. L., NATURE, 152, 509 (1943).

Aerial Disinfection

THE bactericidal action of propylene glycol vapour against air-borne bacteria has been recently discussed by Robertson[1]. The considerations he puts forward seem capable of general extension.

In order to kill bacteria suspended in the air, a lethal amount of the bactericidal agent must accumulate on the bacteria-carrying particles. The purely physical processes involved in this are at least as important as the bactericidal power of the substance itself. Condensation of the bactericide on to the bacterium will be favoured by: (*a*) saturation or near-saturation of the air with the bactericide; (*b*) solution of the bactericide in the bacteria-carrying particles, which may usually in this context be regarded as a watery solution. When equilibrium between the particle and the bactericidal atmosphere is established, the partial vapour pressures of bactericide and water in the atmosphere and over the particle will be equal. This equilibrium will be attained very rapidly with particles of a few microns in diameter. Death of the bacteria will follow if the concentration of bactericide in the final solution is lethal.

Working on this basis, desiderata for an aerial antiseptic would seem to be, in addition to bactericidal activity and lack of toxicity to man: (*a*) low vapour pressure, so that it is possible to work near to saturation; (*b*) water solubility, so that the bactericide will condense readily on to moist particles; (*c*) stability in room atmospheres, that is, freedom from liability to oxidation or other chemical decomposition, or to absorption by walls and textiles.

In addition to the phenols and the glycols, other classes of compounds appear likely to contain members fulfilling these conditions, for example the hydroxy acids or the amino alcohols. Tests have been made on the bactericidal activity of vapours of lactic acid, mandelic acid and triethanolamine. All these have given good kills of the organisms of sprayed saliva (*S. salivarius* and others) at concentrations of 10, 8 and 150 mgm./cu. metre respectively with relative humidities about 70 per cent and temperatures of 60–70° F.

More detailed experiments have been carried out with lactic acid, and good kills (better than 90 per cent in 5 minutes) have been obtained on the organisms of sprayed saliva at relative humidities ranging

from 40 to 85 per cent and on dust from a hospital blanket, mainly carrying a sarcina, at humidities of 60–80 per cent. Both heat volatilization of the pure acid, or its aqueous solution, and dispersal as a fine spray in aqueous solution, produce bactericidal atmospheres when the acid is in a concentration of 30 mgm./cu. metre; at one third of this concentration it is much less effective. The majority of the tests were carried out in an 800 cu. ft. room at 60–70° F. and the bacteria sampled on to serum agar plates in a slit-sampler[2]. The kill was confirmed by collecting the bacteria directly into broth in an impinger and plating out.

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Dec. 11.

[1] Robertson, O. H., *Science*, **97**, 500 (1943).
[2] Bourdillon, R. B., Lidwell, O. M., and Thomas, John C., *J. Hygiene*, **41**, 197 (1941).

A Thermolabile Accessory Growth-factor to Rhizobium

IN addition to the thermostable accessory growth-factor (Allison and Hoover's coenzyme *R*), we have found a thermolabile accessory growth-factor to the root-nodule bacteria.

The medium was prepared by grinding 20 gm. of air-dried vetch powder (stem and leaves of *Vicia sinkiangensis*) with 20 c.c. normal caustic potash solution; when well rubbed, the paste was put into a cylinder containing 1,000 c.c. distilled water and was kept overnight. Next morning the supernatant fluid was transferred to a clean container, to which was added enough phosphoric acid to neutralize the alkali, and also 10 gm. sucrose and 3 gm. calcium carbonate. The resultant medium was then made up to 1,000 c.c., sterilized either by autoclaving for 25–30 minutes at 15 lb. per sq. in. pressure or by filtering through a Chamberland *F* (*L5*) candle attached to a filtering press. The autoclaved medium was distributed in 9-c.c. portions to test tubes before sterilization. The filter-sterilized medium was transferred to sterile test tubes aseptically after filtration.

Nodule bacteria strains 107 (of pea group) and 520 (of cowpea group) were used as test organisms. The inoculum was made up by washing a slant culture of the organism with approximately 10 c.c. of sterile water. A loopful of bacterial suspension was inoculated to each tube. The cultures were incubated at 25–30° C. for five days or more. Table 1 shows a typical result, in which cold sterilized medium gives more than three times the growth on autoclaved medium. Repeated experiments of the same kind established the presence of a thermolabile accessory growth-factor, stimulant, though not necessary, to the growth of root-nodule bacteria.

TABLE 1. DIRECT MICROSCOPICAL COUNT OF 11 DAYS BACTERIAL GROWTH (STRAIN 520) IN MILLIONS PER C.C.

Autoclaved medium	Cold-sterilized medium
31·5	114·0

A second series of experiments was then carried out to investigate the response of the thermolabile factor to heating. Test tubes containing cold sterilized vetch extract medium were heated for 30 min. at 40°, 60°, 80° and 100° C. in a water bath. In addition, unheated tubes and autoclaved tubes containing the same medium and autoclaved tubes containing the standard yeast-water-sucrose medium were included for comparison. Table 2 gives results of one experiment of this kind. The result shows that bacterial growth diminishes with increasing heating of the medium prior to inoculation, while there is no definite thermo-inactive point. The cowpea bacteria strain 520 seemed to have responded more readily to the thermolabile factor than that of the pea bacteria strain 107.

TABLE 2. DIRECT MICROSCOPICAL COUNT OF 5 DAYS BACTERIAL GROWTH IN MILLIONS PER C.C.

Strain	Yeast-water-sucrose	Auto-claved	Vetch extract medium				Not heated
			100° C.	80° C.	60° C.	40° C.	
520	139·1	0·6	44·8	43·6	59·2	71·5	128·0
107	143·6	78·6	85·2	119·0	105·3	120·2	126·1

Owing to the very poor laboratory equipment at our temporary war-time quarters, which are without a refrigerator to keep stock medium, and with crude chemicals, we were not able to give reproducible quantitative data between two independent sets of experiments. Nevertheless, within each individual experiment, the presence of a thermolabile factor which affected the growth-rate of root-nodule bacteria was unmistakable.

Further studies on this newly found factor are under progress so far as facilities and time permit.

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Localization of Vitamin C in *Belascaris marginata*

THE distribution of vitamin C in many vertebrate tissues is now well known, but excepting the Protozoa, knowledge of its localization in invertebrate tissues is somewhat limited, and no work, to our knowledge, has been carried out on the Nematoda.

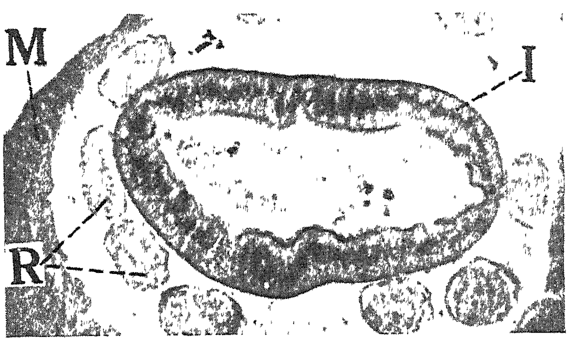

Fig. 1.

Using the usual silver nitrate–acetic acid technique (for the validity of which see Barnett and Bourne[1]), we have investigated the localization of vitamin C in the tissues of *Belascaris marginata*. In specimens taken from dogs fed on a normal mixed diet, we have shown that a large aggregation of vitamin C can be demonstrated in the walls of the intestine. Fig. 1 shows part of a transverse section of Belascaris stained

by the silver technique. The impregnated granules are localized almost exclusively in the intestinal cells (I), whereas the muscular tissues (M) and reproductive organs (R) contain only very minute and scattered grains.

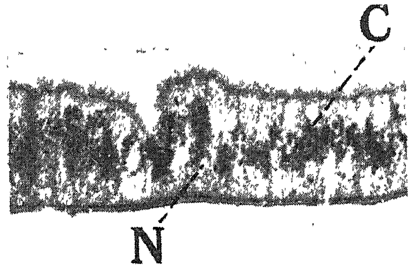

Fig. 2.

The intestinal cells are shown enlarged in Fig. 2. The deposit (C) is typically in the form of approximately spherical granules concentrated close to the nucleus (N) towards the pole nearest the lumen of the gut. It is evident, from these observations, that the parasite can absorb considerable quantities of vitamin C from the food of the host. In this way, it seems likely that the whole vitamin C metabolism of the host may be upset by the presence of the parasite. Thus it may be that in the case of heavy infections especially, absorption of vitamin C by the parasite might be sufficient to cause deficiency effects in the host. Further investigations in cases of infected hosts kept on normal and scorbutic diets may provide some interesting results.

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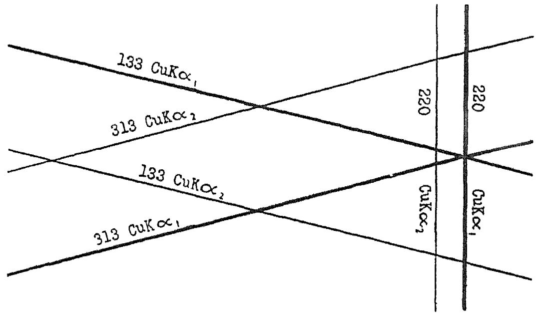
[1] Barnett, S. A., and Bourne, G., *J. Anat.*, **75**, 251 (1941).

Divergent-Beam X-Ray Photography

IN a recent communication[1] I described a simple way of taking photographs of single crystals using a widely divergent beam of X-rays, and suggested possible uses for this method.

Further study has shown that the patterns obtained from cubic crystals provide an accurate and easy way of determining the positions of the symmetry elements in crystals of unknown orientation. All that need be known is the orientation of the crystal specimen relative to the photographic plate or film. The directions of the symmetry elements are obvious at a glance on the photograph, and can be measured with ease. This is possible even if the specimen contains more than one individual.

The examination of a considerable number of diamonds has shown that divergent-beam photography with copper radiation provides a quick method of selecting type II or good type I diamonds. Type II diamonds (transparent beyond λ 3000 in the ultra-violet, and showing no extra spots or streaks on a Laue photograph apart from the usual thermal spots) give a pattern in which deficiency and reflexion (white and black) lines stand out very clearly indeed against the grey background obtainable in an exposure of a few seconds. Good type I diamonds (opaque beyond λ 3000, and giving reasonably intense groups of extra



spots and streaks on Laue photographs) give extremely bad divergent-beam photographs. The lines, when they can be seen, are very sharp, but they are barely discernible against the background. Incidentally, I have found that although out of some five hundred diamonds examined quickly with a small direct-reading spectroscope and good ultra-violet source, only one was obviously transparent beyond λ 3000, not many (6 in 28 tested) of the apparently normal 'opaque' variety gave really good type I Laue photographs. In those that did, however, the correlation between *good* extra spots and *bad* divergent-beam photographs was very striking. Although the significance of the extra spots of non-thermal origin is still obscure, a reasonable explanation of the difference between the divergent-beam photographs of the two types may be given if, as has been generally supposed, the type I are comparatively 'perfect', or, at least, monolithic in structure, and the type II are 'mosaic'. Ordinary organic crystals, such as anthracene or benzil, give quite good divergent-beam photographs.

The method has also provided a very precise determination of λ/a (X-ray wave-length in the crystal/lattice-constant) for copper $K\alpha_1$ radiation and diamond. It happens that one point of intersection of the 313, 133 copper $K\alpha_1$ conics lies very nearly on the 220 copper $K\alpha_1$ conic. The angular separation of the two is given by

$$\left[\sin^{-1}\sqrt{2}\,\frac{\lambda}{a} - \tan^{-1}\frac{2\sqrt{2}}{3} + \cos^{-1}\frac{19}{2\sqrt{17}}\cdot\frac{\lambda}{a}\right],$$

which leads to the value $\lambda/a = 0{\cdot}431889$ for exact coincidence. On my enlarged photographs the $\alpha_1 \rightarrow \alpha_2$ separation for the 220 reflexion is about 4 mm. and the distance from the (313, 133) intersection for α_1 to the corresponding intersection for α_2 is about 6 cm. A change of lattice constant of 1 in 70,000 (0·05 X.U.) moves the point of (313, 133) intersection by about 0·25 mm. relative to the 220 line, and this is easily observable by eye. Since the method is a null one, depending only upon the almost exact coincidence of two directions in space, one of which varies rapidly with variation of λ/a, it is singularly free from any possibility of experimental error. There are no measurements that cannot be made with any ordinary ruler, and no fine adjustments to go wrong. The diamond can be orientated anyhow relative to the photographic film, and the exact crystal → film distance is immaterial, so long as the relevant 'coincidence' comes within the range of the photograph. Full details of the method will be published elsewhere.

The value of λ/a given above leads to a lattice-constant of 3·55974 kX. if the wave-length of copper $K\alpha_1$ *in vacuo* is taken as 1·537395 kX. and the refractive index for diamond as 0·999989. Individual diamonds have been found to have lattice-constants

varying over a range of about 3·55970 ± 0.00020 kX. (at 18° C.), the limits of error for any one diamond being ± 0·05 X.U. (1 kX. = 1000 X.U.). The upper limit of my measurements (3·55990 ± 0·00005 kX.) was found for a diamond which had been so blackened by heat-treatment that it was almost opaque; although its Laue photograph showed also the powder lines of graphite (the graphite flecks extending throughout the volume of the crystal) it remained nevertheless a good single crystal of diamond, type II. The lattice constants of the two types of diamond showed no consistent variation.

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[1] NATURE, 151, 52 (1943).

Secondary Non-Laue Reflexions from Phloroglucine Dihydrate

DR. LONSDALE[1] found a type of non-Laue reflexion from diamond which is different from the usual type of diffuse spots, and she mentions them as secondary extra reflexions. The spots of this type are, as distinguished from the primary type, extremely sharp for a special orientation of the crystal with respect to the incident beam, and may occasionally be drawn out into streaks as the crystal deviates from this orientation. Non-radial streaks in monochromatic X-rays have also been found by Lonsdale and Smith[2] in the case of benzil.

In a rotation photograph of phloroglucine dihydrate crystal about its c-axis, it was found that continuous streaks appeared connecting the spots on row lines. On oscillating the crystal through narrow angular ranges, these streaks became more prominent, but they appeared as broken short lengths corresponding to the range of oscillation. The very slow falling off of intensity along the lengths of these streaks indicated clearly that superposed on the regular crystal lattice there was an effect showing a breaking up of lattice along the c-axis, while along the a and the b axes the crystal was perfectly regular. That is equivalent to saying that, in the Laue equations: $a_0(\alpha_0-\alpha) = h\lambda$, $b_0(\beta_0-\beta) = k\lambda$, and $c_0(\gamma_0-\gamma) = l\lambda$, the first and the second equations remain true, while in the third there is a randomness superposed on the regular periodicity along c. Hence if one takes a Laue photograph with X-ray beam incident along the c-axis, one would expect to obtain cross-grating diffraction spots. This was indeed found on taking such a photograph. Actual calculations showed that the positions of these diffraction spots agreed accurately with those obtained from the first two Laue equations for both the copper $K\alpha$ and copper $K\beta$ radiations (except when $h = 0$ or $k = 0$), and these are extremely sharp, in fact showing the exact shape of the irradiated crystal. Laue photographs with the X-ray beam along b and c directions also confirm this breaking up of the periodicity along the c-axis alone.

These diffraction effects occur over and above the ordinary diffuse reflexions, which are much weaker than is usual for organic crystals, except that the reflexion corresponding to the plane (201) is very strong.

It is very remarkable that the central parts of these secondary spots are quite clear. That this is a real effect has been proved by using a number of different crystals of various sizes and from different crops. This clear centre is not present, however, in the case of the Bragg reflexions, either from oscillation photographs or Laue photographs, or in the case of primary extra reflexions. That the secondary reflexions are produced by the outer parts of the crystal and not by the central portion has been substantiated by taking a Laue photograph from a crystal cut along a diagonal as well as by allowing a very narrow beam to be incident on the central part of the crystal only. In the former case, the secondary diffraction spots are of a triangular shape with the middle of the side corresponding to the cut diagonal clear, while in the latter case these spots completely vanished.

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[1] Proc. Roy. Soc., A, 179, 8 (1941).
[2] Proc. Roy. Soc., A, 179, 315 (1941).

Abnormal Dissociation in Flame Gases

SOME experiments have recently been made with a flow calorimeter consisting, essentially, of a vertical water-jacketed tube fitted with a burner the height of which could be varied at will. Two similar resistance thermometers, one consisting of a plain platinum-rhodium wire and the other a quartz-coated wire, each being of the same overall diameter of 0·0005 in., were placed side by side in the gas stream. The products from the flame could be cooled to any required extent before passing the wires by raising or lowering the burner.

The results of a series of experiments with the burner at different heights to give different degrees of cooling of the flame gases are shown in the accompanying table. The mixture supplied to the burner was 25 per cent carbon monoxide plus 75 per cent air in all cases.

Experiment No.	Distance of burner to wires (in.)	Approximate time for gases to reach wires (sec.)	Quartz-coated wire temperature (° C.)	Plain wire temperature (° C.)	Difference in temp. of two wires (° C.)
1	1·5	0·2	1020	1180	160
2	3·5	0·4	960	1080	120
3	5·5	0·7	870	980	110
4	7·5	0·9	800	870	70
5	9·5	1·2	730	770	40
6	13·5	1·6	570	570	0
7	17·5	2·1	420	420	0

It will be noted that there is a marked difference in the two temperatures, the plain wire consistently giving the higher value. This is clearly due to the phenomenon of abnormal dissociation[1]. The interesting fact, however, in these experiments is that the difference in the temperatures recorded by the two thermometers persists until the gas temperature is reduced to about 500° C. This corresponds to the lapse of about 1½ sec. after combustion.

Thus it is established that abnormal dissociation can persist in flame gases when they have been subjected to considerable cooling.

The exact time and temperature at which the two thermometers will record the same temperature, thus

showing that abnormal dissociation has been eliminated, will no doubt be dependent on the geometry of the calorimeter, since this will govern the degree of contact of the flame gases with surface.

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Nov. 29.

[1] David and Pugh, NATURE, **145**, 896 (1940); also David, Leah and Pugh, *Phil. Mag.*, vii, **31**, 156 (1941).

A New Technique for the Ultimate Microanalysis of Organic Compounds

WE are grateful to F. B. Strauss[1] for the interest he has shown in our paper on the above subject[2], and for his trouble in giving the list of references. Our statement to which he refers was ambiguous, but this was due to editorial reduction to economize paper. In our original manuscript we stated: "We originated this unpacked tube technique for the ultimate analysis of coal. . . . So far as we are aware this was the first time it had been demonstrated that carbon and hydrogen in organic compounds could be determined by combustion in an unpacked tube. . . . we have now sought to apply our technique to the micro scale." This was altered to the form referred to by Strauss, to which we did not object since the ultimate analysis of coal is taken to imply principally the determination of carbon and hydrogen, and it has been customary to include the sulphur determination with the proximate analysis[3].

All except two of the references given, namely, those of Warren[4] and Marek[5], deal with the determination of sulphur alone, and we were fully cognizant of this work. Indeed, some of it was the basis of our present work, although in our original paper[6] we referred chiefly to its technical application by Vita[7] and Seuthe[8], who based their work on that of Mixter[9]. Presumably, Schöberl's paper[10] is the micro method referred to by Strauss, since all the other references deal with macro methods. It should be pointed out that because sulphur can be determined successfully by combustion in an empty tube it does not necessarily follow that carbon and hydrogen can be. Indeed, Mixter[9] states that in his determinations on tobacco and coal respectively, a small amount of hydrocarbon gases and a small amount of tarry matter passed over unconsumed. In addition, ter Meulen and Heslinga[11] state that in their determination a slight deposit of soot which is difficult to avoid is no serious detriment provided all the sulphur is burnt to sulphur dioxide. It would appear, therefore, that it is possible to get complete sulphur recovery without perfect combustion, and therefore our investigations on the determination of carbon and hydrogen were undertaken.

The papers by Warren[4] and Marek[5] do deal with the determination of carbon and hydrogen, and we are glad to learn of them. It is of interest to examine the differences in technique compared with ours. Warren used a combustion tube packed with asbestos for a length of 10–12 in. and, moreover, recommended that a layer of copper oxide should be placed before the asbestos; so his method can scarcely be said to use an unpacked tube. Marek's work is of greater interest since he does appear to have achieved some remarkably accurate analyses using an unpacked tube. However, he admits that most of them were obtained using a platinum contact, which he somewhat naïvely says was not used because of its catalytic powers but to prevent possible explosions and also as an indicator of the course of the combustion. Thus neither of these workers recommend the use of an unpacked combustion tube.

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[3] Parr, S. W., "The Analysis of Fuel, Gas, Water and Lubricants" (McGraw-Hill Book Co, 1942), 27. Engelder, C. J., "A Laboratory Manual of Gas, Oil and Fuel Analysis" (Chapman and Hall, 1931), 168. Moore, E. S., "Coal" (Chapman and Hall, 1922), 48.
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[10] Schoberl, A., *Angewandte Chem.*, **50**, 334 (1937).
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Two New Carbonyls: Copper and Tellurium

WE are able to report the isolation of copper carbonyl, which we obtained from the reaction of carbon monoxide with heated cuprous oxide. It is a white, readily sublimable solid, the vapour of which is dissociated at a higher temperature with the consequent deposition of metallic copper. Only small quantities are formed, but enough has been collected to afford a preliminary analysis indicating $Cu(CO)_3$ as the empirical formula. A polymeric form would be expected in the case of copper, and its properties suggest that it is very possibly dimeric.

The copper mirrors obtained by Bertrand[1] and by Zelinski[2] by treating cupric oxide with carbon monoxide were thus probably correctly explained by them as due to a carbonyl. No record appears of any attempt by either author to separate the substance. Presumably the oxide contained some cuprous oxide, for we found that cupric oxide did not respond to carbon monoxide, and here we are in agreement with the findings of Mond and Heberlein[3]. From this and other work, Mond and Heberlein concluded that copper does not form a carbonyl. However, Boomer, Martin and Argue[4], using a catalyst made of equal parts of copper, aluminium and zinc in methanol synthesis, obtained an aqueous condensate which, after effervescence, precipitated a yellowish solid believed to be a hydrated copper oxide. In any event, copper was the only metal present. Special interest is attached to the observation because the more effective the catalyst the more the copper removed, as though an intermediate volatile copper compound, possibly a carbonyl, were the active agent. The volatile compound was not further characterized.

We have obtained tellurium carbonyl by the action of carbon monoxide on tellurium. The yields in this case, too, have been very small, but it has been shown to be a gas, and a comparison of its physical properties with those of selenium carbonyl, first isolated in these laboratories[5], and carbonyl sulphide make it clear that its formula is COTe. As expected, it has proved less stable than carbonyl selenide.

Details of these investigations will be published elsewhere.

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Nov. 27.

[1] Bertrand, *C.R.*, **177**, 997 (1923).
[2] Zelinski, *C.R.*, **177**, 1041 (1923).
[3] Mond and Heberlein, *J. Chem. Soc.*, **125**, 1222 (1924).
[4] Boomer, Martin and Argue, NATURE, **129**, 438 (1932)
[5] Pearson and Robinson, *J. Chem. Soc.*, 652 (1932)

Ice-Crystal Haloes

A NOTE in NATURE of March 13, 1943, p. 300, reported the occurrence at Bournemouth of what was interpreted as the arc of contact to the 46° halo. Without complete data positive identification of the arc in question is not possible, but it is far more likely to have been the common circumzenithal arc.

The circumzenithal arc is formed by refraction through the 90° angles of ice prisms floating with their axes of symmetry vertical (Fig. 1). Because their orientation is fixed except for freedom to rotate about the axis of symmetry, this arc is well coloured ; it may be faint, but the colours are always relatively pure, in sharp distinction from those of the other arcs and rings.

The true upper contact arc to the 46° halo depends for its formation upon a predominance of crystals floating with a 90° refracting edge horizontal (Fig. 2). As these prisms are otherwise randomly disposed the colours must be broken, and the arc will appear brownish-red.

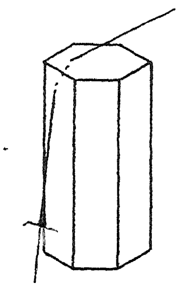

FIG. 1.

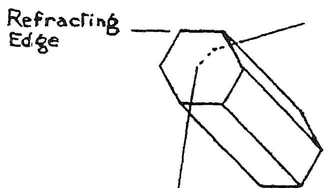

FIG. 2.

The conditions for the formation of the circumzenithal arc are readily fulfilled by the presence of umbrella-like crystals consisting of a flat plate on top of an elongate prism, or of prisms pyramidal at the lower end and hollow in the centre. It is difficult, however, to visualize the type of crystal that would give rise to the contact arc, which, if reliable records were available, might prove to be as rare as the parhelia to the 46° halo.

The mention of colour in the Bournemouth arc, the low sun at 4 p.m., February 8, the lack of mention of any 46° halo, and the commonness of the circumzenithal arc, make it reasonably certain that the latter was the arc in question. This arc may be expected any time that parhelia to the 22° halo occur with a solar altitude of less than 32°, provided that the cirrostratus sheet extends overhead.

My observations for the year ending October 15, 1943, may give some idea of the relative commonness of the better-known ice-crystal phenomena :

22° halo	190 days
Parhelia to 22° halo	38 days
Circumzenithal arc	13 days
Sun pillar	9 days
Circumscribed halo of 22° halo (including contact arcs, that is, incomplete halo)	8 days
46° halo	6 days
Horizontal or parhelic circle	5 days

It may be noted that the rainbow was seen on four days in this period and the fogbow (white rainbow) once. These and earlier records show that some of the ice-crystal phenomena are considerably commoner locally than is the rainbow. The fact that many people have never seen even the 22° halo is partly due to a disinclination to look close to the sun or high in the sky.

In three years of consistent observations I have seen Lowitz' arcs four times, and a 19° halo, the counter-sun and the parhelia to the 46° halo once each. The last two were part of a beautiful display already described[1]. I have yet, however, to see the contact arc to the 46° halo.

From 15° to 25° solar altitude the circumzenithal arc is virtually tangent to the large halo, but outside this range it quickly departs from it. The confusion of these arcs is widespread, and is even revealed in the records published by Pernter[2]. The distinction is emphasized by Minnaert[3], whose fascinating book is recommended to the interested reader.

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[1] Savile, *Mon. Weather Rev.*, **69**, 73 (1941).
[2] Pernter, J. M., "Meteorologische Optik" (3rd Edit., 1902).
[3] Minnaert, M., "Light and Colour in the Open Air" (London, 1940).

Grey Mould (*Botrytis cinerea*) of Flax

IN the course of the examination of large numbers of samples of flax seed by the Ulster method[1] for the presence of seed-borne parasites, many were found to be contaminated with *Botrytis cinerea*. As in some of the samples more than 25 per cent of contaminated seeds was recorded, the pathogenicity of the isolate from home-saved seed was investigated, since *B. cinerea* is known to cause grey mould of flax.

Seeds from a sample known to be free from any known parasite were dipped into a suspension of spores prepared from a pure culture of *B. cinerea* isolated from flax seed. The inoculated seeds were sown in pots of moist sterilized soil which were then covered with sterile bell jars. A few days after the appearance of the cotyledons a number of seedlings produced from inoculated seeds showed brownish-coloured lesions on the hypocotyl at about soil-level ; these seedlings afterwards developed the typical symptoms of 'damping off'. Conidiophores first appeared on that portion of the hypocotyl which was originally attacked, and within a short time spores were produced on all aerial parts of the dead seedlings. No difficulty arose in making isolations of the causal organism from the hypocotyls of seedlings showing early symptoms of attack. Seedlings in control pots sown with uninoculated seeds remained healthy provided the covering bell jars were not removed. The experiment was repeated using spores from isolates from diseased seedlings, and similar results were obtained. The work was carried out in an unheated greenhouse during the summer.

Van Poeteren[2] investigated the control of grey mould by seed disinfection and obtained good results.

The efficacy of those seed treatments which were found to give a good measure of control of other seed-borne diseases of flax in Northern Ireland[3] was accordingly tested. The effectiveness of each treatment was determined in the laboratory by the modified Ulster method[4], five hundred seeds being examined in each case. Treatment with 'Nomersan' at the rate of 12 oz. per cwt. of seed or with 'Ceresan U564', using an 8 per cent solution at the rate of 0·9 gal. per cwt. of seed, reduced the contamination of the seed with viable *B. cinerea* from 15·0 per cent in the control to 0·4 and 1·4 per cent respectively in 1942 and from 13·1 per cent (control) to 1·2 and 1·6 per cent respectively in 1943. Organo mercurial powders applied by the 'fixation' method of seed treatment were not so effective.

In pot experiments made both in the greenhouse and under an open outdoor verandah very satisfactory control of the disease was obtained by the use of both 'Nomersan' and 'Ceresan U564'. In field tests 'Ceresan U564' was very effective, 'Nomersan' also giving good results. Unfortunately, in the field trials made in 1942 the development of the disease was almost completely checked at a very early stage by the onset of cold dry weather, and the yield of fibre was not influenced by treatment. In a similar field trial in 1943 the disease did not appear even in the control plots, probably due to the cold weather which followed sowing.

Observations made in the field show that *B. cinerea* can attack and kill portions of stems of mature plants, and that it is often present on the stems and capsules of plants if prolonged periods of damp weather occur after the crop has been pulled.

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[2] Van Poeteren, H.. *Versl. en Meded. Plantenziektenkundigen Dienst te Wageningen*, 44, 60 (1926).
[3] Muskett, A. E., and Colhoun, J., *Ann. Appl. Biol.*, 30, 7 (1943).
[4] Muskett, A. E., and Colhoun, J., *Ann. Bot.*, N.S. 6, 219 (1942).

Future of Anthropology

PROF. LE GROS CLARK[1] takes exception to remarks which I made in reporting a discussion on the future of anthropology at the recent centenary meeting of the Royal Anthropological Institute. The point at issue concerns the scope of physical anthropology. It would be generally agreed, no doubt, that this is a practical question concerning the convenience of study rather than an attempt to frame a logical definition of a subdivision of science.

Prof. Le Gros Clark refers to his presidential address to Section H of the British Association in 1939. In this he adopts the commonly held view that physical anthropology is concerned with the evolutionary history of man. This is a historical theme though it embraces the study of existing populations. Contact is made with the activities of students who are concerned with living peoples but who have no special interest in any historical theme. It is clear that research in this field cannot be divided into a number of separated compartments. It should all be related and interdependent, however various the approaches may be.

In the communication referred to, the physical anthropologist is urged to study "comparative racial physiology". His subject, we are told, should be *completely* re-orientated "along functional lines", its *main* concern (the italics are mine) being the study of physical efficiency in "native populations", with reference to all factors which influence it—such as inborn differences, nutrition and other environmental conditions—and all other relevant kinds of evidence, including medical and demographic statistics and the application of various physiological and other tests. But why restrict the scope of such inquiries to native populations, since anthropology is concerned with the whole of mankind ? Are its students also expected to carry out research on the same lines for all "advanced" populations as well ?

It is clear that research of the kind referred to is needed, and that its results would be of interest to physical anthropologists. The question is whether they can be expected to consider that problems of the kind referred to should be their special concern. If they do, then the diversion of their very limited resources—at present almost non-existent in Great Britain—must entail neglect of 'academic' physical anthropology. Alternatively, it may be supposed that researches into the social biology of any kind of society can be more properly considered the concern of other workers, whether they be called social biologists, or eugenists, or something else. They might well urge that investigation of the questions involved, which are of immediate practical importance, should be undertaken by the State and not left to university workers.

Prof. Le Gros Clark exclaims at the suggestion, which he incorrectly attributes to me, that physical anthropologists cease to be such if they deal with practical problems. I should say that in so far as they do so, they are serving the 'applied' rather than the 'pure' interests of their science. Zoologists are not expected to be specialists in animal husbandry.

THE WRITER OF THE ARTICLE.

[1] NATURE, 152, 689 (1943).

Mathematics as a Cultural Subject

THE plea in the editorial in NATURE of November 13 on "Science as an Educational Discipline" will find a warm welcome from those who have been concerned with spreading an understanding of the broad significance of science for modern society as well as the details of particular parts of science. Paying less attention to sharp division of science into different subjects and more to the interrelation of these subjects, the history and development of our great heritage and the social possibilities which it holds forth will help to spread a better appreciation of what science stands for among the population at large.

Here I would like to urge that mathematics should also be treated from the same point of view, and should not be put on one side as though it were totally different. The conventional approach to the subject only too often seems to make it appear mysterious, esoteric and external to the pupil's experiences. Without a clear understanding of what mathematics can do and what it cannot do, then it is very easy to be misled by all kinds of arguments using quite unjustifiable mathematical proofs. If mathematics is linked up more closely with the physical sciences, then it is possible to explain the significance of such developments as the calculus and graphs, and to

show that they represented a real advance for mankind instead of merely examination examples; the exaggerated emphasis on plane deductive geometry will give place to a better understanding of the spirit of mathematics. Judging from the school syllabuses, one would imagine that every mathematician was continually using logarithm tables, whereas the present tendency is more and more to use machines both in commerce and in research laboratories.

It is not possible, however, to estimate correctly the importance of mathematics if it is only considered in relation to the physical sciences. Mathematics is very closely related to both the natural and the social sciences, although so far in history the main impetus for its development has come from the former; this is mainly because society hitherto has been much more interested in the natural sciences because of their immediate importance in technology. Nevertheless, statistics owes its development to the social sciences. Even at quite an elementary level, a proper treatment of averages brings in ideas which are not common to other parts of mathematics and which are important in the world to-day. During the War, increasing use has been made of the methods of pictorial statistics in order to make numerical results more understandable.

Lastly, it should never be considered that greater emphasis on these broader aspects of mathematics and science is only of value to the 'man in the street' and not to the expert. To-day we are meeting all kinds of interconnexions between apparently unconnected parts of science, and the person who specializes on one narrow section without appreciating its relation to the whole of modern knowledge is apt to take longer in his work and not see its true significance when completed.

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Area Heating

HAVING been responsible for many large district heating plants on the Continent, I have read with great interest the article "Area Heating" in NATURE of October 30. It is often said that in Great Britain, with its mild climate, there is no need for district heating. The ever-increasing number of central heating plants, however, shows the urgent demand for centralized, labour-saving heat supply; and by the adoption of district heating, relatively more coal can be saved in Britain than on the Continent. By co-ordination of heat and electric-power generation, it will be possible to reduce the present consumption of coal for heat and electric power generation in towns and cities more than by half, and to eliminate entirely the smoke nuisance with all its evil effects.

The co-ordination of heat and electric power generation is, however, a more complicated and difficult matter than it appears to be from Dr. Hughes's article. The thermal efficiency of electric power generation from steam greatly depends upon the vacuum, and the cooling water is heated in the condenser to a temperature of 85°–100° F. only, which is of no use for heating purposes. Higher temperatures can only be attained by an increase of the back-pressure, and this is accompanied by a corresponding increase in steam consumption for electric power generation. A further difficulty is that the hourly, daily and seasonal variations of the heat and electric power loads do not coincide. The daily variation can be overcome, as Dr. Hughes rightly pointed out, by hot-water storage, but this method is not applicable for seasonal variations.

According to Dr. Hughes, after the War new electric power stations will be required. Should it be the case, it would be better, from the point of view of district heating, to install the new generating capacity in existing stations as back pressure sets for heat and electric power generation. This will give a much greater flexibility for development of district heating than new large heat electric stations.

The suggestion of Dr. Hughes to burn the coal in new boiler stations located on the rim of large centres of population and to transmit the steam to turbo-generators located at the centre of gravity, disposing of the heat in the surrounding domestic and industrial areas, is probably due to a misapprehension. In my paper before the Institution of Heating and Ventilating Engineers[1], I showed the possibility of electric power generation in two, or even three, pressure stages when co-ordinated with district heating. In the primary station, steam of high pressure is used for electric power generation with back pressure sets, and the steam of, say, 200 lb. per sq. in. abs. is transmitted to the older station to feed the back pressure sets for electric power and heat supply. Thus the boiler house can be eliminated and generation of electric power and heat is made possible inside a town without the burning of coal. The steam from the primary station must, of course, be delivered to the secondary station with sufficient superheat. Therefore, the steam main must be carefully insulated to reduce the loss of the valuable superheat as much as possible. But even mains carrying low-pressure steam or hot water and accumulators have to be carried out with good insulation. Owing to the increased transmitting capacity, the percentage of heat losses of large mains is very small. The actual heat losses and their costs, however, are practically proportional to the area of the pipe surface. The economic thickness of the insulation has, of course, to be calculated for every scheme, but it has generally been found that good insulation pays.

The saving in fuel was the main argument for the introduction of district heating in the U.S.S.R. That country is now leading in the development of district heating, and the new electric power stations are already predominantly built for co-ordinated heat and electric power supply.

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[1] "Experience with District Heating in Europe and U.S.A. and its further Development". *J. Inst. Heat. and Vent. Eng.* (November 1935).

I AM particularly glad that Mr. Margolis has been prompted to publish more relevant information on area heating, and to correct some of my speculations based on the technical data already available. I certainly did not intend to convey the idea that area heating could be effected from existing plant. I agree that the location of boilers at a distance from the generating station is probably uneconomic, but if the advantages to a community are sufficiently recognized, maybe the community might sanction the excessive cost.

L. E. C. HUGHES.

RESEARCH ITEMS

Genes and Development

IN two papers, H. Grüneberg (*J. Genetics*, **45**, 1–22, 23–29; 1943) describes his recent work in analysing the manner in which genes causing abnormalities in the mouse exert their influence. A recessive gene *ch* results in the development of hydrocephalus, but the most interesting point is that the final effects of the gene are due to anomalies in the early development of cartilage. As a result of the aberration in cartilage development, there is a shortening of the basi-cranial cartilage and nasal septum. This gives rise to a dorsal bulging of the cranial hemispheres. The lower part of the brain is compressed and interferes with the normal drainage function of the foramen of Magendie; hence hydrostatic pressure is increased. The bulge thins out the osteogenic membrane and prevents the formation of the membrane bones. Strain on the blood sinuses leads to internal hæmorrhage, while skin strain gives rise to other anomalies. These various pleiotropic effects are thus shown to be secondary effects of the cartilage anomaly. Grüneberg claims that pleiotropism does not exist, but that a gene produces only one chemical reaction; and there is no reason to suppose that genes have more than one action. The gene, says Grüneberg, is cell- or tissue-specific and never organ-specific in action. He suggests five postulates for the analysis of gene action, which include biochemical and morphological methods. In the second paper Grüneberg describes two further mutants in the mouse—fidget and hydrocephalus—which present interesting features for similar developmental studies in the future.

Development in Drosophila

C. H. WADDINGTON (*J. Genetics*, **45**, 29–44) and C. H. Waddington and R. W. Pilkington (*J. Genetics*, **45**, 45–50; 1943) describe the effects of several leg and eye genes respectively in *Drosophila melanogaster*. The obvious effects of the leg genes dach, dachous, comb-gap and four-jointed are seen in the foreshortening of the legs, but they also affect other parts of the body. In combination, there is found additive effects and exaggeration phenomena in different organs in an apparently inconsistent series. Waddington considers that the explanation should be sought in the effect of the genes upon the folding of the imaginal buds. Where abnormal folding of the buds takes place by aberrant growth, the succeeding abnormal histogenesis will give rise to the various pleiotropic effects. Indeed, X-ray radiation of the imaginal buds during their growth gives similar abnormal folding and similar manifestations in the characters. Waddington and Pilkington have traced the development of eyes of Drosophila carrying the genes facet, lozenge-spectacled, ophthalmopædia and morula. Several remarkable divergences from normal development are described. The authors consider that, as in the work described in Waddington's paper, the genes disturb the method of folding of the imaginal buds.

Wheat-Puccinia Relationships

ALTHOUGH the haustoria in *Puccinia graminis Tritici* penetrate the cells, they remain external to the protoplasts, and the latter can be plasmolysed independently of the haustoria, which themselves are plasmolysed by solutions with concentrations 3–4 atmospheres higher. This aspect focuses renewed attention on the permeability of the host cells, as in a recent paper (Thatcher, F. S., *Canad. J. Res.*, C **21**, 151; 1943). Haustorial invasion always seems to be accompanied by an increase in the permeability of the host cell, often to the extent of being fatal. Treatment of plants with chloroform vapour, which increases the permeability of the protoplasts, leads to a lowering of resistance. Cold hardening, which also increases the permeability of the host cells, in some cases lowers the resistance, but this effect is probably offset by the increase in osmotic pressure induced at the same time. When the wheat variety Kubanka is grown at 80–85° F., the increase in permeability of the host protoplasts caused by the higher temperature seems to be the cause of the rapid early growth of the fungus—later the host protoplasts appear to have an adverse effect on the parasite, since just before they die they cause the formation of brown walls round the haustoria and a kind of encystment. This results in the 'browning reaction' characteristic of Kubanka when grown at high temperatures. Certain varieties, which appear to occupy a threshold position between resistance and susceptibility, give an 'x' or 'mesothetic' reaction with certain races of *Puccinia graminis Tritici*. Infection rapidly leads either to pustules or resistant brown flecks, often both on the same leaf. Host cells from pustule and fleck areas showed higher and lower permeabilities respectively than did those from normal healthy areas. The mature resistance of Hope wheat may be due to its possession of a low water availability to the parasite—seedling leaves have a higher permeability and are less resistant than mature parts. The susceptibility of the host to rust is not modified by previous infection with smut, neither in oats, barley and maize nor in wheat.

Mineral Deficiencies in Fruit Trees

Two recent papers add to our knowledge about mineral deficiencies of fruit trees (*J. Pom. and Hort. Sci.*, 20, Nos. 3 and 4; 1943). J. B. Duggan (pp. 69–78) has succeeded in restoring the green colour to the leaves of cherry trees which were chlorotic through manganese deficiency. This was accomplished by injecting solid manganese sulphate into large branches and into the trunk. Neither injection nor spraying with solutions of the salt was satisfactory in practice. The deficiency of manganese was established by spectrographic analysis of the leaves. D. W. Goodall investigated the intake of calcium, iron, magnesium, manganese and potassium into the apical, middle and basal leaves of various kinds of shoot and spur of the apple Cox's Orange Pippin. He found that intake of the various ions varied with manurial treatment. Samples from plots receiving sulphate of ammonia, for example, contained 42 per cent more manganese than from the plots without added nitrogen. Differences in the manganese and potassium status of different trees are reflected more clearly in the composition of the basal leaves of the fruiting spur than in that of other leaf types.

New Methods in Plant Breeding

DELPHINIUM species and varieties are diploid, tetraploid or hexaploid. Intercrossing between these groups will naturally lead to sterility if the hybrid is obtained. *D. cardinale* is a diploid species with a distinctive scarlet colour. G. H. L. Mehlquist, C. O. Blodgett and L. Bruscia (*J. Hered.*, 34, 187; 1943) have used several methods of applying colchicine to

this species and have obtained tetraploid derivatives. These have been used in crosses with commercial tetraploid varieties of *D. elatum*, to introduce the scarlet colour and the high resistance to Erysiphe (powdery mildew) of *D. cardinale* into existing varieties. So far a few hybrids have been obtained, but many more can be expected.

Forms of Phosphoric Oxide

IT has long been known that phosphoric oxide (P_2O_5) exists in different crystalline and glassy forms. W. L. Hill, G. T. Faust and S. B. Hendricks (*J. Amer. Chem. Soc.*, 65, 794; 1943) have made a study of the preparation and identification of the different modifications, measurements of their optical constants, the phase transformations by the quenching method, and an interpretation of vapour pressure data. They conclude that there are three crystalline forms: hexagonal, rhombic and a stable (probably tetragonal) form, as well as a glassy form. The system involves three triple points at which solid, liquid and vapour (P_4O_{10}) co-exist in equilibrium, and there are at least two distinct liquid forms, one a stable polymer of the other, which were identified with the melting of the stable and hexagonal forms, respectively. Some X-ray data are given for the three solid forms. The stable form can be superheated above its melting point.

Bonded Deposits on Economizer Heating Surfaces

IN a paper on this subject read recently in London by J. R. Rylands and J. R. Jenkinson before a joint meeting of the Institution of Mechanical Engineers and the Institution of Electrical Engineers, it was pointed out that the problem of boiler plant availability in power stations has become so prominent that a better understanding of the causes of the fouling of heating surfaces by deposits from the products of combustion is essential. Earlier theories based on fused ash particles, sodium sulphate bond or high dew-points have not satisfactorily accounted for various well-established facts of observation. The latter include the existence of a period of apparent immunity from deposits in a new boiler plant, the characteristic behaviour of the dust from pulverized fuel firing and the peculiar scale-like form of certain hard deposits occurring on economizer and boiler tubes. The authors have found that hard bonded deposits on economizers result from certain chemical reactions between fuel dust and sulphuric acid. The type of reaction depends on the temperature of the metal parts associated with the deposits. Practical suggestions for the prevention of hard bonded scale formation in economizers are made, various types of coal ash being discussed, and characteristics favouring bonded deposit formation pointed out. The influence of the authors' proposals on plant design is considered.

Solar Prominences

AN important paper by E. Pettit (*Astrophys. J.*, 98, 6; 1943) deals with the classification of solar prominences according to their association with sunspots, their origin, their motion and their structure. A tentative evolutionary sequence includes prominences of the quiescent, active, eruptive, sunspot and tornado types, and a new type, the coronal prominence, is distinguished. A comparative description of each type is given, and subdivisions of many of the classes are illustrated by diagrams and photographs. The paper forms a valuable summary of the results obtained by the assiduous study of the solar surface at the Yerkes and Mt. Wilson Observatories during the past two decades.

Multi-Colour Photometry of Stars

A NEW photo-electric photometer for stellar work has been recently brought into use at the Mount Wilson Observatory, and is now described by J. Stebbins and A. E. Whitford (*Astrophys. J.*, 98, 20; 1943). With the 60-in. reflector, measurements can be made in a spectral range as wide as 3530–10300 A. on stars as faint as the ninth magnitude. The photocell used is of the cæsium oxide type and is especially sensitive to red radiation. A series of filters enables measurements to be made at six points from the ultra-violet to the infra-red. The instrument was designed to measure the colours of faint extended sources such as the nebulæ, but some results on stars incidental to the main programme are now published because of their intrinsic interest. These concern the colours of 69 stars of types *O* and *B* showing various degrees of reddening by interstellar absorption. Small deviations are found from the λ^{-1} law of reddening, in the sense that the radiation is fainter in regions intermediate between the ultra-violet and infra-red, but the law is the same for all directions in the galaxy. Even the simple λ^{-1} law requires *ad hoc* assumptions regarding the size distribution among the absorbing particles, and the deviation found will give further material for study. That the form of the reddening is constant simplifies matters somewhat; evidently equilibrium has been reached and the interstellar cloud must be regarded as a permanent feature of the galaxy.

Determination of Time Corrections

THE Astronomical Institute of Sciences of the U.S.S.R. has issued "Ephemerides for the Determination of Time Corrections by Equal Altitudes (Zinger's Method) for 1941". Four quantities for each pair of stars are tabulated, these quantities depending only upon the co-ordinates of stars entering the given pair. The values of the four quantities refer to the moment of upper culmination of a fictitious star over the Greenwich meridian. The right ascension of this star is the mean of the right ascension of the two stars, and the moment of upper culmination is called the moment of culmination of the pair. Tables are given which provide these four quantities in a continuous reckoning through every ten culminations, that is, through ten sidereal days. In the heading of each pair of stars selected are numbers which denote the various working ephemerides, and the names of stars corresponding to the numbers are given in Table IV. Full explanations of the use of the ephemerides are given with examples, and the necessary calculations are very easily effected. In addition, it is shown how the calculations of chronometer corrections are carried out, and these are facilitated by a special table compiled for the purpose. Special attention is directed to the fact that, in computing the long-period terms of nutation, certain terms are omitted which have been newly introduced by some ephemerides, such as the "Nautical Almanac" and the "Berliner Jahrbuch". It is shown that the total effect of these terms on the half-sum of the right ascensions is negligible. The effect of the short-period terms of nutation are easily computed by means of special tables given for the pairs of the ephemerides by Prof. Zwetkoff.

FEEDING WASTE APPLES TO POULTRY

By H. TEMPERTON
National Institute of Poultry Husbandry, Newport, Shropshire

THE domestic poultry-keeper in return for the cancellation of each shell egg registration is entitled to purchase sufficient 'balancer meal' to furnish approximately half the total dry matter requirements to support one laying bird. This specially compounded meal is richer in protein and minerals than would be the case of a ration designed as the sole food for layers, and its composition has been so formulated that when supplemented by appropriate quantities of edible waste, mainly of a carbohydrate nature, from the kitchen and garden, it provides a suitably balanced ration for egg production. During the past three years a considerable amount of experimental evidence has accumulated on the use in poultry rations of surplus or waste products of the garden or allotment.

At this Institute we have received from time to time inquiries from poultry-keepers concerning the nutritive value of windfall and damaged fruits from dessert and culinary varieties of apple and from ornamental crab trees. Correspondence which has appeared in the poultry Press recently lends confirmation to the belief that there are many domestic poultry-keepers with access to supplies of these types of fruit who are uncertain of the advisability of feeding them to their stock. It has been claimed by some that the organic acids present in apples and pears, and particularly malic acid, exercise a pronounced laxative effect which may result in enteritis when appreciable quantities of fruit are consumed by the birds. Bayon[1] discredits this view on the grounds that the organic acids present in the fruit are less concentrated than the free acid of gastric juice. There are no references in the available literature to experimental observations on poultry, but Klimmer[2] makes the general statement that malic, tartaric and citric acids, which occur in the juices of many so-called acid fruits, all aid the digestive processes, promoting the digestion of albumen, and, in the presence of sugar, influencing the solubility and absorption of certain phosphates and other mineral salts which are insoluble in their absence.

The feeding trial which is now described was designed to provide a more factual basis on which to give advice.

The supply of apples used was of two types: (1) a heterogeneous sample of windfalls from culinary and dessert varieties collected from the ground in September and comprising badly bruised and scabbed fruit; (2) fruits picked at the same time from trees of the Siberian crab (*P. malus* var. *sibirica*).

A sample of the crab apples showed on chemical analysis the following percentage composition:

Moisture ..	83·0	*Dry matter*	
Dry matter ..	17·0	Crude protein	5·00
		Ether extract	0·97
		Crude fibre	4·60
		Nitrogen-free extractives	85·63
		Ash	3·80

Owing to the difficulties of obtaining a representative sample no analytical data were determined on the cultivated apples. For the purpose of this qualitative test five parts by weight of either source of apples were considered to provide the equivalent dry matter of one part of meal.

A group comprising ten first-cross pullets were used for the experiment and were housed in individual laying cages in a battery house and fed the following rations (oz. per bird daily):

	First 14 days	Remainder of test
Layers mash	4·0	3·0
Apples	5·0	10·0

The available supply of crab apples only provided for seven days feeding at the higher level and these were used during the fifth week of the test. During the first fortnight apples constituted 55·5 per cent of the gross weight of food eaten. The apples were minced by passing them through a vegetable shredder, and the juice which was expressed was conserved and used to mix the residual pomace and mash into a wet feed. The day's supply of food was provided in one meal given in the morning. No difficulty was experienced in getting the birds to consume the daily quota of food; on the contrary the ration appeared to be markedly palatable. The physical condition of the droppings remained normal and there was no evidence of scouring. After the test had been in progress for fourteen days the daily amount of mash allowed per bird was reduced by one ounce and replaced by a further five ounces of apples, which now constituted 76·9 per cent of the total weight of food offered. The appetite and general health of the birds were unaffected by this increase or by the subsequent inclusion of crab apples in the ration.

The experiment came to an end after forty-eight days, when the available supply of fruit was exhausted.

Experience at the Institute with laying pullets kept in individual cages in a laying-battery and fed an *ad libitum* supply of the particular meal used in the present instance has shown that the average daily consumption has been about 5 oz. per bird. On this basis the use of apples as part of the diet effected over the entire feeding period of forty-eight days a saving of 34·1 per cent of mash, or just over 5 lb. per bird, and constituted 72·1 per cent of the gross daily weight of food consumed. At the conclusion of the tests the average body weight of the birds showed an increase of 9·1 oz. No deaths occurred, and the health of the birds as judged by external characteristics was unimpaired by the rations fed. The short duration and limited scale of the test afford little more than indications of the effects on egg production. Average egg production is not a reliable reflexion, since two birds did not reach sexual maturity until after the test was concluded and others only came into lay towards the end.

The egg yield of individual birds which were in lay when the experiment commenced remained satisfactory and equal to that of similar birds receiving unrestricted access to a balanced laying mash.

The results of the test demonstrate that no toxic effects to laying birds are likely to follow the feeding of substantial quantities of ripe apples of the types used in the present instance. I am, however, not inclined to discredit the claim that under certain conditions the ingestion of apples can lead to pronounced digestive disturbances and impair the health of fowls, since observations have shown that where poultry, and more particularly young stock, have had access to unripe windfall apples these have been

readily eaten and followed by severe scouring. The experiences of youth provide an eloquent testimony of the diverse digestive effects following the abnormal intake of sour and ripe apples.

The disappearance of acidity due to the utilization of organic acids in respiration and in the synthesis of sugars is one of the concomitants of fruit ripening, but it is unlikely that this provides a valid explanation of the physiological disorders caused through eating unripe fruit, since medical experience indicates that the acidity of the digestive tract is entirely dependent on factors influencing the amount of the gastric secretion and its hydrogen-ion concentration.

Archbold[3] has demonstrated that the first stage in the growth-phase of apples following petal-fall is characterized by the formation of cell-wall material, and the intake of nitrogen. It is possible that the toxicity of immature fruit is due to a relatively high content of non-protein nitrogenous compounds, which are regarded as the principles responsible for similar physiological disturbances in larger farm livestock when unripe mangels or large quantities of young grass are suddenly introduced into the diet.

[1] Bayon, H. P., *Poultry Farmer* (August 20, 1943).

[2] Klimmer, M., "Scientific Feeding of the Domestic Animals" (Baillière, Tindall and Cox, 1933).

[3] Archbold, *Ann. Bot.*, **46**, 418 (1932).

CLEANSING OF MILK BOTTLES

MOST of us have received the familiar wide-mouthed milk bottle with its pressed-in cardboard stopper and, wiping with some anxiety its dirty neck, have wondered whether the milk is fit to drink. Remembering the difficulties of war and aware of the psychologist and his dirt-complex, we have reflected that anyhow the milk in our bottle is all the milk we can get and have tried not to be too fussy about it. The 'authorities', we know, have our cows tested for tuberculosis and do what they can to see that the milk we get is as clean as possible before it goes into the bottles ; the medical men—and some others—wrangle interminably about the obvious advantages of pasteurization ; but may not all these efforts be stultified by inefficient methods of washing, filling and distributing milk bottles ? May not a roundsman who is naturally unaware that he is a typhoid carrier undo all the labours of those who have provided him with typhoid-free milk ?

The first answer to these natural anxieties of the milk consumer is the Milk and Dairies Order, 1926—note the date—which requires that all milk containers and all appliances which come into contact with milk shall be thoroughly washed as soon as may be after use and shall be cleansed and scalded with boiling water or steam before they are used again ; the second answer is that the Ministry of Health, three years before the War, asked for a survey of bottle-washing plants to find out whether treatment of them with caustic detergents was as good bacteriologically as steam sterilization. The results of this inquiry, carried out between October 1937 and July 1939, by G. S. Wilson and Betty C. Hobbs, were given in a full report to the Ministry, a copy of which can be seen at the library of the London School of Hygiene and Tropical Medicine. An abridged version appears in the *Journal of Hygiene* (**43**, 96–120 ; 1943).

Its conclusions can be given only briefly here ; on the whole, they will reassure the householder. They agree largely with the results of similar investigations in the United States. A total of 2,406 milk bottles from 105 washing and distributing plants of 26 different types was examined. Hand washing of bottles is condemned. Small dairies often disregard the Milk and Dairies Order. Steam sterilization is efficient if it is carefully done ; otherwise it is not. But on the whole, equally good results were obtained in large and small rotary plants with either steam sterilization or hot caustic detergent (caustic soda with or without additions). The spray type of washing machine was the best, and the best results were obtained without brushes. Virtual sterility could be obtained with either strong caustic soda at a low temperature or with weak caustic soda at a high temperature, and it is not necessary to change the detergent more often than occasionally, provided that it is brought daily up to strength and that foreign matter is filtered out and deposit in the tanks is removed every few days.

One very interesting result was that no coliform bacilli were found in the washed bottles. The detergent killed these. This would eliminate, in well-conducted plants, milk-borne diseases derived from homes from which empty bottles are returned ; but can we be sure that all plants are conducted well enough to ensure this ? Of the organisms found in the washed bottles about half were saprophytic, one quarter were cocci and one quarter were yeasts, moulds, hæmophilic organisms and aerobic spore bearers. These, like the coliform bacilli, would have been killed by the detergent, so that they must have got into the bottles after they had left the detergent. It was found that most of them came from the rinsing water used to get rid of the detergent, which was heavily contaminated.

United States workers have recommended the use of chlorinated water to remove the detergent and to check the bacteria in the rinsing water, but Hobbs and Wilson prefer a rinse in water at 120° F., followed by cooling by washing the exterior only of the bottles at decreasing temperatures, until a temperature of 70° F. is reached. A final cold spray from the water main over both the outside and inside of the bottle completes their process. If bottles are hotter than 68° F. when milk is put into them, the life of the milk will suffer. Frequent cleaning of the washing machines is, of course, desirable.

To these complex problems of washing and cooling on a large scale must be added the important one of storage of bottles in small plants, where they are kept some hours or even overnight before they can be filled. Bottles should never be stored the right way up. When they are inverted their bacterial content depends on the amount of moisture and the temperature ; in warm damp weather it is likely to be higher.

Householders will be glad to learn that the familiar wide-mouthed bottle with its cardboard stopper is condemned ; it would be more satisfactory if a hooded cap covered its neck. A narrow-necked bottle with a press-over cap, or a bottle with recessed angles, would lessen the risk of contamination of the milk when it is poured over a dirty and frequently handled brim. A paper-board container which is used only once is the ideal, but it is too expensive at present.

The importance of clean milk bottles is shown by reference to the literature on typhoid epidemics and other milk-borne diseases. In the United States, 296 out of 373 outbreaks of typhoid were traced to carriers either on the farms or in the milk-distributing plants.

While we need not, in Great Britain, be unduly alarmed by such figures as these, the fact remains that clean milk is a vital concern of the whole community. If the farmer and the veterinary surgeon do their best to give us clean cows and clean milking, we should see to it that the bottling and distributing organizations do not introduce disease. The householder has an important responsibility too—he should see that used bottles are well washed in hot water before they are returned to the roundsman, especially if there is communicable disease in the house. The problem is complex, requiring, like so many features of our modern civilization, the willing co-operation of all who take part in the chain of operations which link the producer with the consumer. The authors of this paper are to be congratulated on the completion of a very complex and difficult piece of public work. Before they could do it they had to work out methods which are valuable contributions to knowledge.

G. LAPAGE.

PALÆONTOLOGY WITHOUT FOSSILS IN THE 'BIRD-WING' BUTTERFLIES

EVER since the days of the immortal Wallace, biologists have been intrigued with the distributional problems presented by the fauna of the Malay Archipelago. Probably the butterflies have proved more attractive than any other group, not only on account of their æsthetic charm, but also because the pattern and colour of their wings are susceptible to modification by isolation and climate. There is no doubt that Wallace had the butterflies in mind when he wrote in 1869: "It is certainly a wonderful and unexpected fact, that an accurate knowledge of the distribution of birds and insects should enable us to map out lands and continents which disappeared beneath the ocean long before the earliest traditions of the human race".

The latest contribution to this subject is of considerable interest and is described by the author, Dr. F. E. Zeuner, as "palæontology without fossils".* Essentially, it comprises an attempt to reconstruct phylogenetic trees for the 'bird-wing' butterflies on the basis of the morphology of the species-groups and the present distribution, and the evolutionary patterns thus obtained are compared with the geological history of the Malay Archipelago. The more or less complete agreement found between these two methods of approach is highly satisfactory.

In order to obtain the requisite data for an accurate division of the 'bird-wing' butterflies into species-groups, a considerable amplification of previous systematic work on this genus has been necessary, and this has been carried out principally on the basis of the male genitalia. Accordingly, the 'bird-wing' butterflies are divided into two major groups, the *Troides* Hübner + *Trogonoptera* Rippon group and the *Ornithoptera* Boisduval + *Schoenbergia* Pagenstecher group.

The phylogenetic trees for these two major groups are reconstructed on the reasonable assumption that each of the groups of subspecies existing at the present time has been derived from a common ancestral form in comparatively recent times and that, at some earlier period, each of the species-groups present to-day was a subspecies-group, and so on until a stage is reached when there was a common ancestor for each of the two major groups. All the known species of the Troides + Trogonoptera group can be obtained from a single parent-form on the assumption that this division into subspecies which eventually became differentiated into species has taken place at least five times. There can be little doubt that the common ancestor of the essentially western Troides complex originated in Sundaland, that is, in the continental land-mass formed by the union of the Malay Peninsula, Sumatra, Java and Borneo in the Tertiary. The Ornithoptera + Schoenbergia group can also be reduced to a single form on the assumption of five successive phylogenetic waves. While it is clear that the Ornithoptera complex of species has developed in the Papuan area, its past history is by no means so manifest as that of the Troides group for, in its earlier stages, the distribution of Ornithoptera proper was discontinuous, representatives being confined to the Moluccas and the Solomon Islands, while there was an interclave of Schoenbergia in New Guinea.

Regarding the geological history of the Malay Archipelago, it is evident that the continual fluctuation in the sea-levels between the Malay Peninsula and the islands of Sumatra, Java and Borneo, which resulted in these lands being united and separated repeatedly during the Pleistocene, was a factor of outstanding importance as regards species formation in the Archipelago, and accounts for the very large number of groups of closely allied species existing in Malaysia to-day. Of less importance were the changes in sea-level between the Aru Islands, New Guinea and Australia on the Sahul Shelf during this period, although the effects were similar. The remaining large island groups were isolated throughout the periods under discussion.

The formation of a large number of the geographical races (subspecies) found in Malaysia and in the region of the Sahul Shelf to-day dates from the final elevation of the sea-level after the last low level of the Last Glaciation, whereby the then existing land-masses were separated finally into their constituent islands. While the present subspecies and species of the 'bird-wing' butterflies are approximately of Holocene and late Pleistocene origin respectively, the phylogenetic stages previous to these two belong to the late Tertiary. The author computes that the evolution of the Troides group as a whole has occupied a period of between three and twelve million years.

Two outstanding problems concerned with the distribution of the 'bird-wing' butterflies are the overlap of the two major groups in the Moluccas, and the curious discontinuous distribution of ancestral Ornithoptera, which occurred in the Moluccas and Solomons and was absent from New Guinea. It may be mentioned that one or two of the present-day species of *Euploea* Fabricius (Danaidæ) show a similar hiatus in distribution so far as New Guinea is concerned. Dr. Zeuner considers that both these anomalies are explicable on the theory of continental drift. If New Guinea has advanced to its present position from a more southerly one during the Tertiary and Pleistocene and pushed the Moluccas and Solomons apart, and the Moluccas have been moved round from a position whereby the northern Moluccas occupied a more easterly site than at present, then these distributional problems are resolved.

A. STEVEN CORBET.

* Studies in the Systematics of *Troides* Hübner (Lepidoptera Papilionidae) and its Allies: Distribution and Phylogeny in Relation to the Geological History of the Australasian Archipelago. By Dr. F. E. Zeuner. *Trans. Zool. Soc. Lond.*, **25**, 107-184 (1943).

STUDIES OF POPULATION CHANGES

AMONG the papers read before the American Philosophical Society at its mid-winter meeting, February 19–20, 1943 (*Proc. Amer. Phil. Soc.*, 87, No. 2, August 16, 1943) is one by F. W. Notestein of the Office of Population Research, Princeton University, on "Some Implications of Population Change for Post-War Europe". Mr. Notestein points out that we have been living in a unique period of the world's demographic history—a period of unparalleled population growth, which in Western Europe is drawing to a close. After discussing the fundamentals of population change, he applies general principles based on the vital trends of the inter-war period to derive age schedules of fertility and mortality for the future, from which he and his colleagues have constructed a series of population projections for the years 1940–70 for the U.S.S.R. and each European nation as of the 1937 boundaries. The fundamental assumptions are: (1) that the future course of mortality and fertility will represent an orderly development of the trends of the post-war period; (2) that there will be no international migration; and (3) that there is no war.

These projections indicate that the north-western and central region will reach its maximum population by 1950; in England and Wales, Sweden, Estonia, France, Belgium and Switzerland the maximum will be attained or passed by 1945; in 1955 by Scotland, Latvia, Finland, Norway, Germany, Austria and Czechoslovakia. While the effect of the War cannot at present be estimated, assuming the losses in the present conflict are proportional in each age-group to those of the War of 1914–18, it can be computed that the German population of 1950 will be about 25 millions less because of the decline in fertility and 10 millions less because of the losses of two wars. Accordingly, Mr. Notestein suggests that throughout this region society must be re-oriented towards the interests of children, probably detracting somewhat from the current preoccupation with the needs of the aged. It may also have to be less oriented towards strictly individualistic values and more toward those of the group.

In southern and eastern Europe the principal characteristic of the period 1940–70 is a rapid increase in the persons of working age, and accordingly throughout the period there will be constant danger of pressure of population on developed resources in a region already suffering from pressure of population on its predominantly agricultural economy. Such pressures must be relieved in this region of deep hatreds if strife is to be avoided. Prompt relief, it is claimed, can only come from two sources: absorption of the region by the Soviet Union, which has ample resources and an enviable record in dealing with ethnic heterogeneity, or an economic and political solution by the Western Powers. The latter would be impossible if a series of small sovereign States were set up. The solution lies in the creation of a wide trade area of relatively free migration into which outside capital and skills are brought to foster industrialization and urbanization.

In contrast with the other regions, the Soviet Union faces rapid growth in all sections of its population more than five years of age, and this growth in population will probably be matched with a growth in power. The Soviet Union has ample natural resources to support its prospective population within its present boundaries, and Mr. Notestein concludes that it is difficult to escape the view that the Soviet Union in the coming decades will be the strongest single Power in the world. The United States, in his view, could not wisely stand apart from an association for collective security based on the mutual self-interest of the community of nations.

Included in this symposium of papers on post-war problems is a paper by the late Prof. Franz Boas of Columbia University, which was read before the Society on November 21, 1942. In this paper, "Individual, Family, Population and Race", are briefly summarized the results of an investigation of a number of highly mixed populations, like those of the eastern large cities of the United States, of other groups more uniform because members of a well-defined national group, and by contrast isolated groups that had for long intermarried among themselves, such as the Scandinavians of the Faroe Islands, the East Siberian tribes of the Chukchee Peninsula, Chippeway Indians of a few communities that have for long intermarried, the Bastards of South Africa, the Pitcairn islanders and a mixed Malay Dutch population from Kissar.

The results of the study demonstrate a sharp cleavage between the isolated groups and the two other groups, and Boas infers that there is no human group in existence which is so uniform either in fraternal groups or in family lines that any one individual can be considered as a representative of the group. In other words, there are no characteristics known that would allow us to claim that individual characteristics are determined by traits common to the whole group. The component individuals of any group vary markedly among themselves, and 'race' does not determine human behaviour. While Boas does not claim that it has been proved that biologically or genetically determined characteristics are exactly the same in all populations, he maintains that every known population, no matter on what principles it is selected, shows a wide degree of variation of forms; that no pure human race exists, and that behaviour is much more rigidly controlled by natural and social environment than by descent.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Saturday, January 1

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 3: "Sound Waves".*

Monday, January 3

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 2.30 p.m.—Mrs. Reginald Wyndham: "In the Netherlands Indies", with Kodachrome and other Films (Christmas Lecture for Young People).

SOCIETY OF CHEMICAL INDUSTRY (LONDON SECTION AND FOOD GROUP) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Prof C. R. Harington, F.R.S.: "The Contribution of Chemistry to Immunology" (Jubilee Memorial Lecture).

Tuesday, January 4

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 4: "Visible Light".*

Tuesday, January 4—Wednesday, January 5

AGRICULTURAL EDUCATION ASSOCIATION (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London W.C.1).—Half-yearly Conference.

Tuesday, January 4

At 9.30 a.m. (Agriculture Section).—Dr. John Hammond: "The Breeding of Cattle for Milk or Meat"; Reports by Dr. S. Bartlett and Dr. J. Edwards on "The Reading and Cambridge Artificial Insemination Centres".

At 11 a.m. (Dairying Section).—Mr F. K. Neave: "The Sterilizing of Dairy Utensils by Hypochlorites"

At 11.15 a.m. (Chemistry Section).—Mr. W. Morley Davies: "Plant Nutrition".

At 2.30 p.m. (Paper Reading Session).—Discussion on "The Agricultural Education of the Youth of 15 years of Age and Over" (to be opened by Mr. A. S. McWilliam, Mr. C. R. E. Gillett and Mr. J. Hunter Smith).

Wednesday, January 5

At 9.30 a.m. (Paper Reading Session).—Mr. D J. McLaren. "Some Suggestions for Organizing Instruction in the Care, Maintenance and Use of Implements and Machinery within the County Agricultural Education Framework"; Mr. C. Davies: "Specialised Farm Machinery—What is Necessary and What is Customary".

Thursday, January 6

BRITISH ECOLOGICAL SOCIETY (in the Department of Botany, The University, Oxford), at 10 a.m.—Annual General Meeting.

ROYAL INSTITUTION (at 21 Albemarle Street, London, W 1), at 2.30 p m.—Prof. E. N. da C. Andrade, F.R S.: "Vibrations and Waves", 5: "Short Electromagnetic Waves".*

Friday, January 7

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 2.30 p.m.—Miss Francesca French: "China—the Western End of the Great Wall" (Christmas Lecture for Young People).

INSTITUTE OF PHYSICS (LONDON BRANCH) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Dr. R. Stoneley, F.R.S.: "Earthquakes".

Saturday, January 8

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. C. E. N. Bromehead: "Geology and Health".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R S.: "Vibrations and Waves", 6: "Long Electromagnetic Waves".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEADMASTER of the Ashington Mining School—The Director of Education, County Hall, Newcastle-upon-Tyne (January 7).

ASSISTANT (temporary) IN AGRICULTURE at the Somerset Farm Institute, Cannington, near Bridgwater—The Clerk to the Somerset County Council, County Hall, Taunton (January 10).

TIME AND MOTION STUDY ENGINEERS (Order No. Q.5662S), and TIME AND MOTION STUDY ASSISTANTS (Order No. Q.5663S), for Government Posts in the Provinces—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting appropriate Order No.) (January 12).

TEACHER OF ENGINEERING SCIENCE, MATHEMATICS AND DRAWING in the Junior Technical School—Mr. E. B. Stockdale, Education Office, Mexborough, Yorkshire (January 14).

WOMAN PSYCHOLOGIST (whole time) at Twickenham Child Guidance Clinic—Mr. C. W. Ratcliffe, "R2", Clerk of the Middlesex County Council, Middlesex Guildhall, Westminster, London, S.W.1 (January 14).

TEACHER IN ENGINEERING SUBJECTS (possessing Graduate or equivalent qualifications in Mechanical Engineering and Industrial experience) at the Melton Mowbray and District County Technical College—The Director of Education, County Education Office, Grey Friars, Leicester (January 6).

GRADUATE (temporary) for MECHANICAL OR CIVIL ENGINEERING SUBJECTS, together with MATHEMATICS, at the Denbighshire Technical College, Wrexham—The Director of Education, Education Offices, Ruthin, Denbighshire (January 8).

Acting full-time DEMONSTRATOR OF ANATOMY—The Dean, Medical College, St. Bartholomew's Hospital, London, E.C.1 (January 11).

ENTOMOLOGIST in the Department of Agriculture, Salisbury, Southern Rhodesia—The Official Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (January 31).

LECTURER ON PHYSICS—The School Secretary, St. Mary's Hospital Medical School, London, W.2 (February 1).

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EDUCATION FOR THE VETERINARY PROFESSION

ON p. 60 of this issue we refer to some addresses which were given to the National Veterinary Medical Association of Great Britain and Ireland at its sixty-first annual general meeting in London last September. These addresses, and the discussions which followed them, make it clear that the veterinary profession is—and always must be—of fundamental importance to the health of man and to the progress of his civilization. In times like our own, when the basic importance of nutrition is being so often and so rightly emphasized by responsible authorities all over the world, it will scarcely be denied that without successful agriculture our post-war reconstruction will not succeed; and it will not be denied that the key to successful agriculture is a fertile soil. An important condition of soil fertility is the maintenance of a healthy livestock to fertilize it. Both the veterinary surgeon and the farmer are, therefore, key men of the future. They must always work in collaboration.

These fundamental conditions of successful agriculture have been recognized in recent years by the Ministry of Agriculture and by the Agricultural Research Council. Some years ago these bodies established a network of interacting links between the farmer and the veterinary surgeon on one hand and, on the other, between the farmer and experts in botany, soil science, genetics, farm economics, nutritional science and other branches of scientific inquiry which directly or indirectly affect the production by the farmer of the national food supply. These experts work either in agricultural institutes established and maintained by the Government, or in similar institutes which are attached, sometimes by the financial link only, to the universities. In these institutes or at other key points in Great Britain a number of advisory officers have been stationed by the Ministry of Agriculture, and it is the duty of these advisory officers to keep in touch with the farmers and to interpret to them the results of scientific research. Veterinary surgeons constitute one group of these advisory officers; and they, in the course of their work, bring not only the farmer but also the veterinary surgeon into relationship with the work of the universities. There is nothing in this scheme to bring the veterinary surgeon into relationship with the other great profession which deals with national health, namely, the medical profession; but there is no doubt that the scheme has greatly benefited the farmer and the veterinary surgeon and also the national production of food.

If, however, the farmer needs the veterinary surgeon to maintain his livestock for the purpose of fertilization of his soil and for crop-production, he needs him also to maintain the health and genetical constitution of a livestock which is in itself the raw material of our considerable industry in animals and their products. The value of this industry is estimated by the President of the National Veterinary Medical Association at some £200,000,000 a year. British livestock has, moreover, formed the nucleus

of the best herds and flocks of the Dominions overseas, of the Americas and of many other countries; because of the excellence of this stock, Great Britain has been called the stud farm of the world; and our trade in livestock exported for breeding purposes only has been a valuable one. Our breeding stock is, in the opinion of some experts, still in good condition, in spite of the difficulties of four years of war. Expert opinion, however, agrees with the Minister of Agriculture that this is not true of the general livestock in our fields. If this is so, it is not the fault of the veterinary profession, which works manfully against the difficulties of war to maintain the health of all our domesticated animals. The profession is not a large one. The President of the National Veterinary Medical Association (*Vet. Rec.*, **55**, 395; 1943) states that there are less than 3,000 active veterinary surgeons in Great Britain to-day, about one third of whom man the State Veterinary Service or hold other public, educational or similar whole-time appointments, the remainder being in private practice. They have by their constant vigilance so reduced the risk of the major rapidly spreading epidemics of disease in farm animals that it is negligible in Great Britain and in those of our Colonies where veterinary surgeons have been able to tackle diseases of this kind on their own responsibility. Losses from disease are nevertheless considerable in all countries. The President of the National Veterinary Medical Association estimates that they cost Great Britain £30,000,000 a year. To lessen this loss the veterinary profession is doing all that it can with the resources and facilities placed at its disposal. It has performed, and daily performs, many dull and exacting and unspectacular routine tasks of health supervision, meat inspection and the like. It is clear that its education and its general status is a matter of public importance. A brief review of its organization will help in understanding its position in relation to national affairs and the general trend of changes in this position which have either occurred recently or have been proposed for the future.

When John Hunter sponsored the foundation of the Royal Veterinary College of London, he began a process of education in animal health which will, if we read the signs of the times correctly, proceed to the position which responsible authorities desire, namely, the incorporation of veterinary education in a general scheme for the control of both animal and human health. Four other veterinary colleges now help the London College to undertake the education of veterinary surgeons. These are the Royal (Dick) Veterinary College of Edinburgh, the Glasgow Veterinary College (Incorporated), the Veterinary College of Ireland, Dublin, and the School of Veterinary Science of the University of Liverpool. The creation of two other colleges at Bristol and Cambridge has been recently suggested. All the existing colleges are authorized by Royal Sign Manual to train veterinary students for examinations which are held by one examining body and one only—the Royal College of Veterinary Surgeons. This is a corporate body established by Royal Charter in 1844 and composed of those who have been students of the affiliated colleges mentioned above and who have been admitted to membership of the Royal College by passing the examinations controlled by that College. The Royal College of Veterinary Surgeons is thus to be clearly distinguished from the Royal Veterinary College of London, which is purely a teaching college, and from the National Veterinary Medical Association, which is an association of qualified veterinary surgeons, and is akin to the British Medical Association. The functions of the Royal College of Veterinary Surgeons are analogous to those of the General Medical Council, except that the Council of the Royal College of Veterinary Surgeons has sole control of the only examinations which qualify a veterinary student to practise as a veterinary surgeon and of the examiners who conduct these examinations. Its further duties are to keep a register of veterinary surgeons and to discharge certain functions relating to the ethics of the profession and to the activities of unqualified individuals who attempt veterinary practice. Its functions thus amount to the maintenance of a high degree of professional efficiency and ethical conduct among its members. For some years the Council of the Royal College of Veterinary Surgeons has required the veterinary, like the medical, student to complete a training lasting five years; in this time he has to cover a field of work similar to, but wider in scope than, that covered by the medical man. When he has received the veterinary diploma (M.R.C.V.S.), the veterinary surgeon can, if he likes, take, under suitable conditions, such additional qualifications as the fellowship of the Royal College (F.R.C.V.S.) or the diploma in State veterinary medicine (D.V.S.M.), which are awarded by the Royal College alone, the diploma in tropical veterinary medicine (D.T.V.M.) awarded by the University of Edinburgh, or various postgraduate courses which are designed to give further instruction in pathology, bacteriology and public health, or to give special instruction to those who wish to enter the Royal Army Veterinary Corps or the Colonial Veterinary Services. Some universities also grant degrees in veterinary science, and the D.Sc. and Ph.D. are open to veterinary surgeons doing research in some universities. It is no new thing, either, for chemists, biologists and others to take advantage of the grants provided by the Ministry of Agriculture to become veterinarians as well.

In addition to these opportunities to advance his education and broaden his outlook, the modern veterinarian may look for aid to the funds and wise direction of the Veterinary Educational Trust. This trust, which was founded in 1942, was the subject of a leading article in these columns at that time (NATURE, **150**, 500; 1942). We then commended the aims of its founders, namely, the creation of an animal health organization, together with the provision of scholarships, fellowships and other aids which would do much to provide veterinarians with adequate education and opportunities to do their work; for the veterinarian is, we then insisted, one of the key men in our national affairs. *The Times*, *The Field*, the *Farmer's Weekly* and other far-seeing and well-informed authorities agreed with us then

that the new type of veterinarian who has come into the field must have the best possible training and mental equipment. Great Britain must no longer be reproached, as it is still being reproached, for its continued failure to accord to its veterinarians the status and educational facilities which are provided as a matter of course by other countries.

This brief outline of the existing veterinary education will, however, make it clear that events are moving slowly in the direction advocated in the leading article already referred to. Veterinary education is still too far divorced from the universities, but a nucleus of close collaboration with them exists; the existing system segregates the veterinary student and the qualified veterinarian from university workers, but it ensures a uniform standard in its examinations, and this is denied to the medical man and to some other professions. Whether this uniformity is worth the price paid for it in the dissociation, not only of veterinary students, but also of their teachers, from university life and work it is not our purpose to consider. It is pertinent, however, to direct attention to one aspect of this dissociation—its tendency to hinder the natural contacts between the work of the veterinary surgeon and that of the medical man.

Upon this point and upon the desirability of drawing together these two great professions by means of some educational scheme a great deal could be said by those veterinary surgeons and medical men who agree that it could do nothing but benefit both professions. No other professions are so closely connected as these. Both study the normal and deranged health of animals; both are concerned with the control of diseases which, like tuberculosis, trypanosomiasis, anthrax and others, are communicated to man from his domesticated animals; both are concerned with the production, in adequate quantity and quality and in freedom from disease, of basic foods such as eggs, milk and meat; both have made outstanding contributions to our knowledge of animal morphology, physiology and pathology and to bacteriology and the control of disease. Some men have, indeed, expressed their realization of the common aims of the two professions by acquiring the qualifications necessary to both; and the Royal Society of Medicine, when it established a section of comparative medicine, the proceedings of which are conducted jointly by medical men and veterinary surgeons, expressed its belief in the close co-operation of these two professions.

This co-operation, like the general collaboration between the veterinary surgeon and workers in other branches of scientific inquiry to which we have already referred, is, in fact, increasing in our chief centres of teaching and research. It is not, however, close enough. It ought to be an active, natural liaison. We say liaison because no one would propose that a closer association than this is possible. It would not be possible, even if it could be shown to be desirable, to educate the two professions in the same classes. The first year of their instruction can be so passed. In point of fact, in Edinburgh all students of Surgeons Hall and of the Dental College of Edinburgh are, at the request of their respective deans, doing their first-year physiology, histology and biochemistry at the Royal (Dick) Veterinary College during the War; but as soon as the student goes on to the study of anatomy and physiology, the special requirements and wider scope of the veterinary course make it necessary to give him special classes in the anatomy and physiology of the domesticated animals. He requires to know how to manage and care for these animals; and this is, in itself, a big undertaking, requiring the provision of a farm and a field station; it is, indeed, one of the major difficulties of veterinary education to-day. The veterinary student further requires, as his instruction proceeds, more and more instruction over and above that given to the medical student, who deals with one kind of animal only. No medical school could, for example, provide the clinical material which is essential for the teaching of the diagnosis and treatment, whether this be medical or surgical, of sick animals and for the teaching of veterinary obstetrics. The provision of this essential clinical material is, in fact, another major difficulty of modern veterinary education. It calls for the provision of veterinary hospitals at every veterinary teaching centre. It must be obvious that efficient veterinary education requires its own specially trained teachers and its own independent buildings. This need not mean, however, that an administrative scheme could not realize a close association between the students preparing to enter both the medical and the veterinary profession. It could with advantage require that medical and veterinary students should each utilize to the full the courses of instruction given to the other.

We thus reach the natural culmination of that educational process which began with the foundation of the veterinary teaching colleges. At the present moment the Loveday Committee is reconsidering on behalf of the Government the recommendations it made in 1938 for the improvement of veterinary education; at the same time the country is being told by the medical and lay Press something of the profound re-organization of the medical profession which is in progress. It is true that this medical re-organization appears on the surface to affect chiefly the practical treatment by the doctor of his patients, but it would be short-sighted to suppose that a revolution in practice of this order will not affect profoundly the education and, indeed, the whole outlook of the medical man. He is to become, it is clear, much more of a public servant and much less of an individual who practises, with whatever nobility of purpose, for his own private profit. It may be that a similar change will affect all of us, in one degree or another. The veterinary surgeon is already able to do public service by entering the Colonial veterinary services or the State veterinary service at home.

While changes so fundamental are being considered and planned in both the veterinary and the medical professions, it must surely be wise to consider also whether their education, at least, if not their practice, cannot be planned as a natural whole. Their basis

is the same, their principles are the same, so the end product of their education should be the same. Both professions should study to produce an alert, scientific, public-minded individual whose altruistic outlook moves him to choose as his life-work the science and art which seeks to relieve the sufferings of man and animals and to save their lives when they are attacked by disease. The best way of doing this is, as was pointed out in our leading article a year ago, to study to prevent the occurrence of disease rather than to try to cure it after it has occurred; and this is, in fact, the policy of both the veterinarian and the medical man of to-day. It would be difficult to find a better or a more powerful bond between them. In tune as it is with the whole trend of modern thought, it may well prove to be the only bond which is powerful enough to compose the differences which undoubtedly still exist between these two great professions.

SCIENCE AND RELIGION

Man, Real and Ideal

Observations and Reflections on Man's Nature, Development and Destiny. By Prof. Edwin Grant Conklin. Pp. xvii+247. (D.800.) (New York and London: C. Scribner's Sons, 1943.) 2.50 dollars.

PROF. CONKLIN'S book is well intentioned and well written, but, at least to me, profoundly unsatisfactory. The theme is, in the main, the time-honoured problem of the relation between science and religion, and it would be near the truth to say that, for the author, real man is man as science discloses him, while ideal man falls in the province of religion. Prof. Conklin evidently writes for a public which is still not unaffected by Fundamentalism, for echoes of the Tennessee controversy over evolution lend some of his remarks an asperity which English readers will consider strange. But the pages in which he outlines the evolution of man and the origin of races are clear and easy to understand by the general reader. They call for no comment except recognition of their admirable lucidity. He concludes that "the main direction of human progress has turned from the path of further differentiation of the individual to that of increasing differentiation and integration of society".

In spite of Prof. Conklin's exposition, I remain, as often, perplexed by the word 'evolution'. It seems to me that evolution is not a fact in the sense that it is a datum, but a theory to explain a large number of observed phenomena. What precisely the author's theory may be I find it impossible to say. He is certainly not a thoroughgoing Darwinian. Chance mutations and natural selection are not enough; there is an "unknown factor" in evolution, which appears to be more important than the known factors. All that the author will say about it is the somewhat vague question, "Is it unreasonable to suppose that something basic to intelligence and purpose is found in all organic evolution?" It will not surprise the reader who has made anything of this question that Prof. Conklin believes in a "non-personal" teleological tendency on which he builds rather more than the foundation will stand.

Behaviourism finds no favour with the author, who says, truly enough, that "to deny the reality of subjective phenomena is equivalent to denying the reality of all phenomena", and he inclines to the belief, or should we rather say hope, that divine immanence is the assumption which will maintain something like divine control or direction in evolution without conflicting with science. It is not, I think, unfair to say that when Prof. Conklin comes to deal with metaphysical problems his clearness of thought is obscured and we have the impression that he has not thought the meaning of his assertions through to the end. Thus he calls himself a "scientific realist" and he defines his attitude as follows: "I regard the external world as real and I think that objects are what they seem to be unless by scientific methods it can be shown that they are otherwise". The naïvety of this sentence disarms criticism, but it must be pointed out that almost every word in it raises epistemological problems of the most far-reaching character. We cannot stay on them, but it may at least be remarked that the further "scientific methods" are pushed the nearer we come to the position that *no* objects are "what they seem to be". Nor again can the assertion that idealist metaphysics "denies objective reality and therewith all science" be passed over without protest. The truth is that most idealist theories of the ultimate nature of reality leave science precisely where it was.

Perhaps it is useless to protest against the unscientific attitude adopted in this book to psychical research, because it is so common among scientific writers. Prof. Conklin believes that there is no scientific evidence in favour of personal survival of death, and states, no doubt accurately, that "the anecdotal evidence of psychical research leaves most scientists cold and unconvinced". This is merely an appeal to authority and not the result of an examination of the data, and surely no one who had followed the recent development of psychical research, for example, in the field of extra-sensory perception, could employ the epithet 'anecdotal'.

These are criticisms of detail, though I think of important detail, but it is not upon them that I base the opinion that the book is disappointing. Prof. Conklin has a real respect for religion and a keen perception of its place in human life. He writes eloquently of the pessimism of the 'pure realist' who allows no right to the religious experience. He is deeply concerned for the future of mankind and the preservation of ideal ends in life. He has a sincere reverence for the character and teaching of Jesus. No one could read what he has to say on these subjects without emotion and a feeling of affection for the author. But what does the religion which remains, when realism has done its work, amount to? I cannot see that it comes to anything more than the belief that possibly the hypothesis of God may be, in some undefined sense, true, that there are rather dubious signs of an immanent purpose in evolution, and that, if we all work very hard and keep our ideals bright, we may possibly produce a better world for our great-grandchildren. This will never do. If this is all that religion has of truth it will disappear. The root error of the book is the sharp distinction between reason and emotion and the relegation of religion to the emotional sphere. Religion has always claimed to be 'wisdom', to have an insight into the meaning of the world on which it stands or falls. The fundamental problem is never touched on in this book—the nature of scientific knowledge and its relation to other types of knowing.

Though I regard the book as, in its chief theme, superficial, I would not imply that it is not worth

reading, for it contains much incidental wisdom, mainly of a practical kind. I will conclude by quoting some sentences which express a truth needing to be emphasized. "It is time for some statesman or philosopher, some modern Plato, to draw up a Bill of Duties to match and balance our Bill of Rights. It is said that society owes every man a living, leisure, opportunity, freedom, but there is less emphasis upon what every man owes to society. There are no human rights that have not been earned by human effort, no social rights that are not balanced against social duties". W. R. MATTHEWS.

PROF. MOORE AND PHILOSOPHY

The Philosophy of G. E. Moore

Edited by Paul Arthur Schilpp. (The Library of Living Philosophers, Vol. 4.) Pp. xvi+717. (Evanston and Chicago: Northwestern University; London: Cambridge University Press, 1942.) 30s. net.

THIS book tries to reproduce the conditions of a seminar. There is a common theme: the philosophy of G. E. Moore; there are nineteen philosophers, considering, interpreting and criticizing Moore's presuppositions, approach and philosophic method—both in general and in the specific cases of ethics and the theory of perception; there is, finally, a lengthy answer by Prof. Moore in which he takes up some of the points raised and deals with them with particular relish for fine detail, avoiding, however, treatment of more general problems.

The nineteen essays seem quite independent of each other. None of the authors appears to have had the opportunity of taking account of the content of other contributions. I do not suggest that an agreement about views and a fusion of the exposition would have been desirable; but, if collaboration had been possible, some repetition of arguments in the five hundred pages of criticism might have been avoided and a more connected vision of Moore's philosophy achieved. The lack of collaboration is probably due to quite external circumstances, but the nature of Prof. Moore's reply cannot be thus accounted for. I cannot be alone in my poignant regret that G. E. Moore, after fifty years of philosophizing, embodied in reviews, essays, lectures and only one full-length book, did not give us—instead of a hundred and fifty pages of disconnected detail—a systematic account of his present philosophic position.

But I may be asking for the wrong thing. Perhaps it is not paradoxical to suggest in the face of this very voluminous book called "The Philosophy of G. E. Moore" that there is no such thing as the philosophy of G. E. Moore. There is indeed something: the attitude of G. E. Moore, and G. E. Moore's doubts, even bewilderment, about different philosophies. Something, I think, must here be said about this attitude. But I cannot hope to reproduce in a few words any of the important and penetrating things said by experts in this volume; nor dare I, without the opportunity for elaborate reasoning, contradict their points.

This book also contains an important weapon for the criticism of Moore's philosophic attitude, namely, his autobiography. This weapon, I suppose, has not been at the disposal of his nineteen critics. There is a method of philosophic criticism which is perhaps not universally recognized as fair and relevant; it is Nietzsche's 'unmasking'; that is, the tracing back of philosophic views to personal attitudes. If the autobiography—unlike the photographs included—is instrumental to the work's main purpose of philosophic elucidation, it can only suggest this method. If I seem to administer a kick from behind, I must insist that I have been specially led to take up this position. I quote an illuminating passage from the autobiography: "I do not think that the world or the sciences would ever have suggested to me any philosophic problems. What has suggested philosophic problems to me are things which other philosophers have said about the world or the sciences . . . first, the problem of trying to get really clear as to what on earth a given philosopher *meant* by something which he said, and, secondly, the problem of discovering what really satisfactory reasons there are for supposing that what he meant was true, or alternatively, was false".

I think that Moore's unwillingness to give an author the benefit of the doubt or to try to see—behind the inevitable misuse of language and the cramping effort of philosophic creation—that important insight and satisfactory vision flows from the attitude expressed in the quotation. It is from this point of view that he insists that he does not understand unless he is told in plain English. (Thus, for example, his surprising refusal to understand the word 'postulate' and therefore Mr. Edel's essay.) He is more interested in the minute inconsistencies of terminology than in the broad issues of which they are the vehicle.

Equally his defence of common sense flows from his preference for criticism to philosophic creation. While a defence of common sense may be a salutary corrective to some rash philosophic views, an imaginative conception of philosophy will not see in common sense an independent criterion, but only the popularized philosophy of the day before yesterday.

A different yet connected aspect of Moore's attitude is his position as reviver of 'realism'. I suggest that 'realism' as much as 'idealism' flows from, and is in an important sense largely an expression of, an experience of the way in which a mind works. This is certainly less than the last word about those philosophic schools, but perhaps more than an empirical statement of psychology. Moore's incapacity for, or mistrust of, creative speculation has led him to resign the claim of the mind-dependence of the world, just as Bradley's exuberance of creative force which speaks through his style and imagery tempted him into the elevation of mind to despotic power.

I have no space in which to make fully explicit the presuppositions of my approach. I have not undertaken to decide about the truth of philosophies or to pass value judgments upon them. It is perhaps obvious from my account that I believe much of Prof. Moore's approach futile. But it would be both useless and improper to assert a judgment without the opportunity for a full exposition of reasons. Only the utility of the whole work is here under consideration.

Moore's is a distinctive philosophic attitude which has exercised considerable influence. The critical consideration of this attitude and the ramifications symptomatic of its influence, together with his reply, certainly represents an important document about the state of philosophy in our time, and is rich in suggestions for the future critical historian of twentieth-century philosophy. H. P. REICHMANN.

PENICILLIN: ITS DEVELOPMENT FOR MEDICAL USES*

By PROF. H. W. FLOREY, F.R.S.
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PENICILLIN has received a great deal of publicity in the lay Press during the last year or two, largely, I suspect, because of the somewhat unusual and dramatic circumstances of its discovery and development. Though some of the accounts are substantially correct, others, both British and American, have not been so reliable.

It has been known since Pasteur described the phenomenon in 1877 that in a test tube in the laboratory, the growth of one species of bacterium may be stopped by the concomitant growth of another. It is now known that this is due to the production by the antagonistic micro-organism of a definite chemical product. To these naturally produced chemical inhibitors, the name of 'antibiotic' has recently been given. Pasteur recognized that the phenomenon of antibiosis might be of use in therapeutics, but the first serious attempt to use it was made by Emmerich and Loew in 1899, when they suggested that the products of a common micro-organism, *B. pyocyaneus*, could be used for treating anthrax and diphtheria. It is certainly true that this bacillus produces more than one antibiotic, but the mixture called 'pyocyanase' has never really been shown to be of use in medicine.

In the course of years, many examples of the production of antibiotics were found; in fact in 1929 a monograph was published about them, but none had at that time been employed successfully in medicine.

Discovery of Penicillin

In 1929, Prof. A. Fleming, of St. Mary's Hospital, London, made a very acute observation. He was examining the growth and properties of Staphylococcus. This organism grows readily on a solid medium containing agar. In the course of his observations, Fleming had to lift the lid on and off in order to examine the staphylococci growing in the dish. Now everywhere in the air around us are bacteria and spores of moulds. If the lid of an agar plate is left off for only a few minutes, bacteria and spores settle on the agar and in a few days the surface is covered with a thick growth of bacteria and moulds. During Fleming's short manipulations, a mould spore settled on his agar plate, which was then put aside for a few days. Such a contamination is extremely common, but what was remarkable in this instance was fortunately noticed by Fleming, who had for many years been interested in antiseptics. Around the mould colony, the colonies of staphylococci were undergoing lysis, that is, dissolving.

Fleming took some of the mould and cultivated it in flasks, in liquid broth. He found that during its growth something appeared in the broth which was capable of inhibiting the growth of a number of microbes, including many of those which cause some of the most destructive lesions the flesh is heir to. This substance Fleming called 'penicillin'. The mould was afterwards identified as *Penicillium notatum*. It is not a common mould, and is not the kind found on bread, old boots and such-like.

Fleming found that penicillin-containing broth was not more poisonous to animals than ordinary broth, and that the broth did not appear to harm white blood cells. He recognized that penicillin might be of value in medicine as an antiseptic to apply to infected wounds, and after treating a few indolent septic wounds with the broth, he concluded that, as he said, "it certainly appeared to be superior to dressings containing potent chemicals".

Clutterbuck, Lovell and Raistrick found in 1932 that the mould could be grown on a purely synthetic liquid medium, but they did not succeed in extracting the penicillin from the liquid in stable form. They found, however, that if the medium was acidified and shaken with ether, the penicillin passed into the ether. Unfortunately, when they tried to get rid of the ether and concentrate the penicillin by evaporation, most of the penicillin activity was lost.

Discovery of the Chemotherapeutic Effects of Penicillin

Fleming, and also Clutterbuck, Lovell and Raistrick, concluded that penicillin is a very unstable substance and therefore not likely to be a practicable antiseptic, and the matter rested there until the work was taken up at the School of Pathology, Oxford, in 1939. Since 1929, I had been interested in another discovery of Fleming's—lysozyme—a substance occurring in many animal tissues and secretions which has the power of dissolving certain air bacteria, though unfortunately none which produces disease. The work on lysozyme was continued on the biochemical side during the 1930's, until it was purified by Roberts in 1937, and the material or substrate on which it acted characterized by Epstein and Chain in 1940. During the latter part of this work in 1938, Dr. Chain and I decided that it would be profitable to make a systematic survey of naturally produced antibacterial substances both from a biochemical and biological aspect. The first two to be investigated were the products of *B. pyocyaneus*, the bacterium to which I have already referred, and penicillin. Penicillin was chosen (in spite of the fact that it was said to be very unstable) because it acted against disease-producing bacteria, in particular the staphylococcus. One observation of Fleming and of Clutterbuck, Lovell and Raistrick suggested that penicillin was not too unstable to handle; that was, that its activity might, under certain conditions, be maintained in the original medium for some weeks. At the beginning of the work we thought that penicillin would be an enzyme or ferment like lysozyme, and we were certainly unprepared to discover its remarkable properties which came to light in the course of the investigations. The work which we now began needed the close collaboration of many workers. In addition to Dr. E. Chain, these colleagues have been Dr. E. P. Abraham, Prof. A. D. Gardner, Dr. N. G. Heatley, Dr. M. A. Jennings, Dr. A. G. Sanders, Dr. C. M. Fletcher and Mrs. Florey, with the collab-

* Substance of a Friday discourse delivered at the Royal Institution on December 10.

oration of many surgeons and physicians; I should like to emphasize that without their unstinted efforts the work would never have been carried through to its present stage. Nor must one forget how much was due to our technical assistants, Mr. G. Glister and his 'penicillin girls', Mr. J. Kent and, for the chemical work, Mr. D. Callow.

One of the first steps was the elaboration by Heatley of a quick test for penicillin, which made the quick assay of penicillin-containing fluids possible.

At first the mould was grown in flasks; later, when more material was required, it was grown in larger vessels.

Preliminary experiments showed that penicillin was an acid which in the acid form rapidly lost its activity. It was also destroyed by alkali but was stable at a point which was neither acid nor alkaline, that is, about neutrality. Further, Clutterbuck, Lovell and Raistrick's observation was confirmed that, if penicillin-containing brew was made acid and shaken with ether, the penicillin passed into the ether. The crucial observation was then made that when the ether containing penicillin was shaken with water containing the right amount of alkali, the penicillin passed from the ether back into water. In this way the penicillin could be extracted from the crude brew and partially purified. The processes now used for the preparation of penicillin all depend, at one stage or another, on transference of penicillin from a water solution to an organic solvent and back.

It must be realized that in the early days we had very little penicillin for the experimental work on which some of the essential chemical data were obtained. The main factors affecting the use of penicillin in medicine are that salts of penicillin: (1) are stable about neutrality; (2) they are destroyed by acid and alkalis; (3) by oxidizing agents such as potassium permanganate; (4) by certain metals such as copper, lead and mercury; (5) by some alcohols; and (6) by enzymes or ferments produced by certain air bacteria.

One of the most important points is its destruction by an enzyme or ferment produced by certain air bacteria. These bacteria are ubiquitous and very easily contaminate the fluids in which penicillin is grown. If this occurs, the enzyme produced by the bacteria destroy the penicillin as fast as the mould produces it. It is, in fact, the air bacteria which make large-scale production of penicillin so difficult, for it is by no means easy to carry out manipulations on a large scale while excluding these organisms.

The isolation from the original medium of a protein- and salt-free product made possible a study of the bacteriological and pharmacological properties in detail.

Some of the bacteria highly susceptible to penicillin are *Streptococcus pyogenes* (causing pus formation and such diseases as child-bed fever), *Staphylococcus aureus* (causing bone diseases and boils, etc.), both of which are important in war wounds, *Streptococcus pneumoniæ* (causing pneumonia), *Corynebacterium diphtheriæ* (causing diphtheria), *Clostridium welchii, septique* and *œdematiens* (causing gas gangrene), *Neisseria gonorrhœæ* (causing gonorrhœa), *Neisseria meningitidis* (causing meningitis or spotted fever).

Some much less sensitive are those causing typhoid fever and a form of food poisoning, while some, such as those causing plague, cholera, dysentery and tuberculosis, are quite insensitive. It is thus clear that penicillin is not a cure-all, and it cannot be expected to act except in diseases caused by susceptible organisms.

Most antiseptics, like carbolic acid, kill the germs outright; but penicillin merely stops their growth, that is, it is what is called a bacteriostatic. It interferes in some way not yet clear with bacterial division.

Some of the first material produced inhibited the growth of an organism such as the streptococcus at a dilution of 1 : 1,000,000. We made the erroneous deduction that anything so powerful as this must be fairly pure, but we now know that only about 1 to 2 per cent of the original brown powder was pure penicillin. What is now commonly called penicillin for use in medicine still contains not more than 10–20 per cent of the active material, the rest being coloured and other impurities.

Pharmacological Properties

While this chemical and bacteriological work was proceeding, investigations were also made on its pharmacological properties. The most important points are: (1) lack of toxicity to mice and other animals; (2) white blood cells (leucocytes) and tissue cultures (body cells grown in glass vessels) are unaffected by concentrations of penicillin some hundred of times greater than that necessary to stop bacterial growth; (3) the activity of penicillin is not affected by pus, blood or the breakdown products of dead tissues; (4) its activity is little affected by the number of bacteria present; (5) it is absorbed after injection into muscle or beneath the skin and from the small intestine; (6) it cannot be given by stomach owing to the presence of acid there, nor by the large bowel owing to the presence of bacteria which destroy it; (7) it is very rapidly excreted by the urine, hence large and frequent doses have to be given. It is also excreted in the bile.

Points 3 and 4 are in sharp contrast to the sulphonamides.

It is most important that penicillin has little effect on the white blood cells or leucocytes, for it is to these that we owe a great deal of the capacity of the body to combat infection. If germs gain entrance, say, through a prick in the finger, the blood vessels dilate and certain of the white blood cells emigrate from the blood vessels to the tissues. They move freely about in the tissues, where they take up and kill bacteria if they meet them. But the bacteria produce poisons which kill the white blood cells, and the outcome of the infection is to a large extent controlled by which factor is the greater—the killing of the leucocytes by the bacteria or vice versa.

It will now be appreciated how penicillin acts in combating bacteria which have gained entry to the body. It stops the growth of the germs, while the white blood cells ingest them and kill them off.

The final experiments which demonstrated that penicillin might be useful in medicine were those known as mouse protection experiments. A number of mice are inoculated with germs which will certainly kill them if no successful treatment is given. We sat up through the night injecting penicillin every three hours into the treated group, and I must confess that it was one of the more exciting moments when we found in the morning that all the untreated mice were dead and all the penicillin-treated ones alive. The diseases treated experimentally were

caused by the streptococcus, the staphylococcus and a gas gangrene organism. Against the latter two organisms there is no other really effective drug.

A man is roughly 3,000 times the weight of a mouse, so you can well imagine that the next step, to produce enough to use on man, took months of labour on the scale at which we were then working. Eventually enough was made to give a single small injection to a man. Much to our consternation, the patient started shivering and the temperature rose. Fortunately, the substance causing this reaction was not penicillin, and the impurity was removed quite easily by chemical means.

Work in the laboratory having provided all the necessary knowledge to enable us to say penicillin could be used on man, and what sort of infections it was likely to deal with, the object of the first trials on man was to see if the drug exhibited any toxicity not found in animals and to ascertain the best methods of administration and the necessary dosage.

Penicillin can be used in two ways; it can be injected intravenously or intramuscularly, after which it is carried by the blood stream to the diseased parts. By this means much penicillin has to be used, but it is the only possible way of giving it in many serious illnesses. It may also be used in much less quantities as a local application to infected parts. Its successful use locally clearly depends on being able to reach every part of the diseased area, and one of the main points in its use is the elaboration of the requisite surgical techniques to ensure this.

There is no question that this drug can perform in a remarkable way when rightly used but, as with all new drugs, the initial trials tend to be carried out on what are considered hopeless cases after everything else has been tried. Though it is recognized now that penicillin is a valuable drug, it is still so rare that patients are not treated until the disease has progressed a long way and everything else has been tried. What one looks forward to is its use at the earliest possible moment with the idea of stopping or preventing destruction of the tissues, and so saving much disability and prolonged illness, and even life. It is probably along these lines of prevention, for example, that it will be most profitable to use the material for those wounded in battle.

At the present time there are dozens of chemists both in Great Britain and in the United States, in academic laboratories and commercial firms, engaged on the chemical problems, and we must await the result of their labours with what patience we can. In the meantime, great efforts are being made to improve the yields produced by the mould by means of selecting a good specimen or strain of the mould, and by improving the media. A considerable measure of success has been achieved, particularly by our American colleagues. Just as the Americans have had our information we have theirs, and commercial firms both in Great Britain and America are now doing all they can to make this drug available in quantity in the shortest possible time.

I venture to suggest that in another five or ten years the work I have been describing will be looked on as the first halting steps in the exploration of a whole series of new chemotherapeutic compounds, and I think the discovery and development of penicillin may be looked on as quite one of the luckiest accidents that have occurred in medicine, for without exception all other mould antibiotics so far examined are poisonous.

INFLUENCE OF NEWTON'S WORK ON SCIENTIFIC THOUGHT*

By N. TEICH,
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BY his extraordinary talent Newton was able not only to produce a powerful synthesis of the work done by his immediate predecessors, Galileo and Kepler, but also to add profound contributions of his own to mechanics, mathematics and optics. His method of fluxions enabled him to produce quantitative calculations which raised the level of mechanical science to hitherto unknown heights. The mechanical interpretation of Nature to which he gave such a powerful stimulus became one of the leading factors in the subsequent development of scientific thought.

The question arises now whether it is possible in discussing the scientific side of Newton's influence to omit his influence on the philosophical and social side? Evolution of scientific thought does not depend only on experiments and calculations. It is true that scientific men are in the first place responsible for scientific thought. But they do not live in a vacuum. They are social beings; they take part consciously or unconsciously in the life of society surrounding them. Social ideas which agitate society also affect their ideas.

What was the social background to which we have to look in order to understand the essential levers of Newton's work? Whoever takes a plunge into the history of Newton's period cannot help observing that the intellectual activities of Newton and his contemporaries went side by side with the struggle for political rights between the old nobility and the rising class of merchants. All activities in military and commercial spheres needed the active help of people well versed in the theoretical principles of astronomy (for navigation) and of mechanics (for building simple machines or using cannons). It is not surprising, therefore, that the physical theory of that time occupied itself mainly with the motions of stars or of bodies encountered in everyday experience. People needed scientific knowledge in order to improve their living. What Francis Bacon hoped for when he said that "the roads of human power and human knowledge lie close together" became a reality more than ever before at the time of Newton in England, and at the end of the eighteenth century in France. It is no accident that the essentially materialistic conception of mechanical science scored such a profound victory first in England, then in France, because in these countries the social changes which we associate with the bourgeois revolutions of 1642 and 1789 were favourable to a materialistic philosophy.

Although the immediate social impacts gave rise to the comprehensive theory and practice of mechanics as worked out by Newton, we must not forget the historical continuity which binds the Newtonian outlook to the earlier English materialists, Roger Bacon and Francis Bacon, and to the schoolmen Duns Scotus and William of Occam. English materialistic thought culminated in Newton's work in mechanical science despite the theological limitation Newton imposed on himself.

The brilliant success of Newton's work as applied

* Essay awarded the Foyle Prize of the University of Leeds.

to practical problems of everyday life accounts for the widespread use of mechanical interpretation in nearly every field of human knowledge. Thus David Hartley, the social investigator, in order to justify his own method of approach said: "The proper method of philosophizing seems to be, to discover and establish the general laws of action affecting the subject under consideration under certain select, well defined and well attested phenomena, and then to explain, and predict the other phenomena by these laws. This is the method of analysis and synthesis recommended and followed by Sir Isaac Newton."

At this juncture it might, perhaps, not be out of place to turn to the relation of philosophy to science. Broadly speaking, philosophy at every stage of its development has reflected on Nature, and by proposing a comprehensive view of it has pretended to know it. Although philosophy has often abandoned reality—and thus Nature, the object of its study—we have to give it credit, at any rate, for posing the question of evolution earlier than natural science. Thus the great German philosopher Kant tackled the origin and constitution of the solar system forty years before Laplace. Natural science arose just because official philosophy came increasingly into conflict with everyday experience. Afterwards it became apparent that natural science was taking over one domain after another considered to be under the jurisdiction of philosophy. This development reflected itself in the division of science into physics, chemistry, biology and other branches. This division, of course, was inevitable in view of the complex processes which characterize natural phenomena. Precisely because of this complexity, scientific men were initially unable to see processes in Nature but only phenomena in isolation. In this light we have to see the development of mechanics as a well-defined science, the subject of which was particles in isolation connected only by forces. By the mid-nineteenth century enough was known of natural phenomena to show that they constituted continuously changing processes. Knowledge of these processes through natural science alone was able to give a relatively full picture of Nature. A special knowledge through philosophy could be dispensed with. However, Kant's 'thing-in-itself' lay equally heavy on philosophers and men of science. Thus actually science and philosophy continued to exist side by side, sometimes in mutual opposition, sometimes in mutual support, of each other's theories.

The request for the support of science is a sign of progressive thought. In eighteenth-century France, the absolute monarchy was being undermined by the demands of the middle classes for political rights. Great and daring writers reflected in their publications the approaching storm of the Great Revolution. For our purpose it is important to note that these writers philosophically reared by Descartes based their arguments on science, which meant the mechanical science brought to the highest pitch of perfection by Sir Isaac Newton. The precision by which his theoretical calculations were proved when applied to everyday practice created an atmosphere of confidence as much in scientific as among political circles.

Descartes postulated mechanical science as the focal point of the interpretation of Nature, and Newton demonstrated by actual calculations and experiments the truth of this new scientific thought. Descartes came to the conclusion that mind and matter were separate; Newton through his unrivalled authority in the fields of mathematics and mechanics gave it a form of Papal blessing, showing that the world was able to live on its own, having been given the famous external impulse by a being whom Newton identified with God. The ripest fruit of this Cartesian-Newtonian interaction is perhaps LaMettrie's work "Man the Machine".

The social ferment in France gave rise to a thirst for knowledge. We witness a spread of scientific education, primarily concentrated in artillery schools. Laplace and Lagrange, perhaps the most brilliant Newtonians, were pupils in these schools. Laplace, though as a whole following Newton, was the first to apply mathematics to the problem of the origin of the solar system, which Newton probably considered to be outside scientific investigation. But even his authority could not prevent searching minds thinking about it, because it was realized, if only vaguely, that since everything around changed and developed, there must be some rational origin of the solar system. Incidentally, the Kant-Laplace nebular hypothesis was to be a stepping-stone for geologists to start work on the origin of the earth.

In his attempt to explain natural phenomena Lagrange followed a similar line in his "Mécanique analitique" published in 1787. Newton's "Principia" was published exactly a hundred years earlier. Whitehead points out that these hundred years contained the first period of mathematical physics of the modern type, and that the publication of Clerk Maxwell's "Electricity and Magnetism" in 1873 marked the close of the second period. He thinks that "each of these three books introduces new horizons of thought affecting everything which comes after them".

Though highly mathematical and abstract, these books express the technical and practical problems of the day. Thus it is often said that Clerk Maxwell translated Faraday's work into mathematical language; and Faraday's work was mainly connected with electrochemistry and electromagnetic induction, both of primary importance in industrial practice. It is not without reason that the authors of the above-mentioned books were in the order: Englishman, Frenchman, Englishman. The order reflects the comparative historic importance of their respective countries in the political and economic development of Europe.

With Clerk Maxwell we find ourselves in the nineteenth century. What was the social background of England at that time? Previously, small-scale enterprise developed into factories. England became the workshop of the world. Great problems of power supply and its measurement arose. Such is the social framework into which we have to fit Faraday's work on transformation of mechanical energy into electrical, or Joule's measurements of the mechanical equivalent of heat. A tremendous drive in industrialization was largely possible, because the preliminary scientific discoveries based on the work of Newton and his immediate successors were available. But the industrial revolution begot new scientific problems of its own. For our purpose it is important to note that the scientific men of this time were gradually ceasing to preoccupy themselves with particles and matter, and shifted their interests to fields and energies. We have seen already that Newtonian rigid mechanical assumptions were not accepted unconditionally. Hence the emergence of the Kant-

Laplace theory. In this century physical thought departed more and more from the Newtonian mechanical view. Physicists, in order to describe reality in a profounder fashion, were turning their eyes to the environment of the particles—to the fields which they considered to be stores of energy.

Initially, at this stage, physicists, moulded in Newtonian mechanics, explained energetic phenomena mechanically. The great German scientist Helmholtz expressed it in these words: "The final goal of all natural science is to develop into mechanics". Thus heat energy was recognized to be the outcome of the motion of molecules of matter. Maxwell's mathematical equations provided an all-embracing theory of optics and electromagnetism. Still influenced by the mechanical interpretation of Nature, men of science tried to find a material medium for the propagation of electromagnetic waves. Rapidly advancing scientific technology gave birth to fine instruments which showed a discrepancy between theory and experiment. The medium for wave motion—ether—endowed with many directly opposite qualities, had to be abandoned after the Morley-Michelson experiment failed to prove its existence. The mechanical view receded gradually into the background of the study of dead matter, whereas in biology it was rather unsuccessfully sustained, mainly by the Germans Vogt and Büchner.

From closer study of the history of science it can be seen that scientific advance is not a smooth progress, but takes a somewhat zigzag path. It is continuous and discontinuous at the same time. At any time scientific ideas embody in themselves many older, together with newer, views. Newton's influence in this period was of such a nature. He had been disproved in the question of corpuscular theory of light by Young and Fresnel, he had been looked upon sceptically by those to whom a mechanical method of interpretation of Nature seemed to be incorrect. On the other hand, his general concept of absolute space and time was unchallenged and tacitly assumed. The main function of his space seemed to be to transmit waves of electromagnetic nature of various frequencies, that is, to transmit energy essentially devoid of matter.

In the eighteenth century scientific men believed with Newton that the world was filled with particles, some ponderable, some imponderable. This mechanical view was opposed by the nineteenth-century physicists when applied to the corpuscular theory of light, on account of its inability to explain satisfactorily the interference of light. The corpuscular theory and the wave theory had competed for the favour of physicists since the time of Newton and Huygens and seemed to be irreconcilable. Suddenly, in the early part of the twentieth century, it was discovered that light may possess both properties. As Einstein and Infeld write: "No one thought of applying this concept [that is, the concept of energy] to the corpuscular theory of light. Newton's theory was dead and until our own century its revival was not taken seriously."

The reconciliation was the outcome of a suggestion put forward by Planck to explain certain experimental results in radiation problems. Introducing the elementary quantum of energy, he proposed the atomization of energy. The scientific world was faced with the dilemma of regarding energy as discontinuous after having for a long time considered it to be continuous. Einstein elaborated Planck's suggestion with respect to light energy, when he revived Newton's light corpuscles in his shower of photons or quanta of light energy. If Einstein, on one hand, brought Newton to the fore again, on the other he became aware of the limitations of Newtonian hypotheses. The contradictions in the Newtonian system evolved gradually, aided by the new scientific technique. Thus Einstein and Infeld write: "The theory of relativity arises from the field problems. The contradictions and inconsistencies of the old theory forced us to ascribe new properties to the time-space continuum, to the scene of all events in our physical world." Einstein, in proposing this revolutionary theory, utilized the great advances in physical theory and practice made since Newton. As the field theories are connected with Newton's mechanics, so the relativity theory is connected with field problems. In both cases this close connexion does not preclude the emergence of an essentially new picture of the working of natural phenomena. Thus the new phase of physics includes Newton's physics as part of a more general and richer physical theory corresponding to the new experimental facts.

The formulation of the law of conservation of mass is perhaps the most general reflexion of the mechanical thought which permeated the eighteenth century, when scientific workers were influenced by the thought expressed by Newton: "I am induced by many reasons to suspect that all the phenomena of nature may depend upon certain forces by which particles of bodies by some causes hitherto unknown are either naturally impelled towards each other and cohere in regular figures, or are repelled and recede from each other".

The formulation of the law of conservation of energy reflects, on the other hand, the change in the physical thought of the nineteenth century. Matter and mass were relegated to a secondary position by field and energy. Though the concept of energy helped to advance physics, the physicists were not at all sure what it really was. Whitehead, describing this state of affairs, says that "energy depends on the notion of an organism. The question is, can we define an organism without recurrence to the concept of matter . . . ?"

In the twentieth century, as a direct outcome of the relativity theory, mass and energy are found to be interconvertible. The two above-mentioned laws are combined into one conservation law of mass-energy; and the equivalence foreshadows the wave-particle equivalence in the electron. This contradiction in physics, that we have apparently two opposite concepts describing one of the fundamental units of the material world, can be understood as a contradiction between content and form. The particle side of the electron forms its material content, which has a wave-like form. This contradiction is dynamic and expresses itself in their interconversion. The same on a somewhat higher plane applies to the mass-energy interconversion. Modern physics has arrived at a point where Newton's postulate describing natural phenomena in terms of particles is still fulfilled: yet there is a great difference. Newton and his mechanical school could not explain qualitative changes. To-day we know that physical theory has to take account of the fact that, when things are summed, the process is not only quantitative, but also involves a qualitative change as well. A glance at the table of chemical elements will soon convince us.

Since mathematics proved to be a first-class tool by which natural phenomena can be understood, it is obvious that with the growing complexity of these phenomena the mathematical side is becoming more and more complex, hence more abstract, while through this quantitative treatment our knowledge of Nature is really becoming more and more concrete. This contradiction links up with yet another contradiction which exists between science and social organization. It is a paradox that while the scientific worker is more than anybody else responsible for the great advances of civilization, he is at the same time to a great extent divorced from the realities of everyday life.

This contradictory state in science and society forms the background to the efforts of powerful anti-social circles who would encourage the perversion of science into an instrument of destruction. There are scientific men who, perhaps genuinely trying to build for themselves a philosophical framework within which they can work, support these efforts unconsciously. Their books form a useful ally for those who have no interest in science as a progressive factor of social life. As Sir Charles Darwin says: "They excite the wonder of the reader by suggesting to him what extraordinary difficulties there are in the ideas of physics; they are like a conjurer whose tricks seem to us inexplicable". There are others, happily not a majority, who support such moves wholeheartedly. We have only to quote the Nazi leader Rosenberg about one of these men of science to illustrate the point: "As a thinker Professor Lenard has taught all knowledge is not the same, but souls of alien races produce bodies of knowledge of different spiritual contents".

It is in connexion with these terrible distortions of science that we have to study Newton and his influence on scientific thought, so that this study is not solely of an academic nature. Newton's principles are perhaps best described by Randall, when he says that his most significant contribution lay in the fact that he proved that the ordinary physical laws which hold good on the surface of the earth are valid throughout the solar system. This positive content of Newton's teaching, his objectivism and rationalism, has been transmitted to us by Laplace and Lagrange, by Lavoisier and Dalton, by Planck and Einstein, and in fact has become one of the main features of general scientific thought. The gulf between Lenard and Newton is obvious.

It is in connexion with this gulf that we have to study Newton and his period. There the interdependence of science with the outside world is fairly straightforward. Science and productive forces were in their infancy and their mutual relationship comes out clearly. We can see from it that science has social roots, that the character of scientific progress depends upon social changes. If the main social forces at a definite period are such that men are conscious of their tasks and are striving to solve them, then science progresses too.

What is the task which faces the man of science in this struggle? The answer given by Bernal is: "The task which the scientists have undertaken—the understanding and control of Nature and of man himself—is merely the conscious expression of the task of human society." If we agree with him then we recognize in Newton a great fighter for this aim, and his rationalism and objectivism an essential weapon through the ages which it is our duty to guard.

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THEORIES OF TRICHROMATIC VISION

By PROF. H. HARTRIDGE, F.R.S.

THERE are frequent discussions concerning the rival hypotheses of colour vision, but seldom, if ever, do we see discussed the relative positions of the two rival theories of trichromatic vision. There are two possible plans which present different advantages. These are: (1) That each cone of the retina is able to respond to every one of the three kinds of sensation, red, green and blue; (2) that there are three entirely different kinds of cone, one for the sensation of red, one for the sensation of green, and one for the sensation of blue. The advantages and disadvantages of these two rival hypotheses will now be considered in turn.

The Single-Cone Hypothesis

According to this hypothesis, every cone of the retina is capable of responding to more than one colour sensation. In the fovea centralis every cone can give responses to three colour sensations. In the more peripheral parts of the retina, however, the responses of the cones may be somewhat curtailed to account for the diminution of the colour sense which is found there experimentally.

So far as is known, no single nerve fibre is capable of transmitting more than one kind of nerve impulse. Moreover, each cone of the retina connects with one fibre of the optic nerve and no more. In consequence, every cone must be capable of transmitting up its nerve fibre three different sensations, and this can only be done by variations either in frequency or in the pattern of the nerve impulses which are sent up to the brain. Suppose, for example, that when a cone responds to red rays it sends up its nerve fibre 100 impulses per second, whereas when responding to green it sends up 300 and for blue 1,000. Then, provided that the brain has the necessary structure for recognizing these three different frequencies, recognition of red, green or blue may be satisfactorily explained. When, however, two colour sensations are simultaneously being perceived, there would have to be a transmission of two separate frequencies to the brain. It does not seem easy to picture the simultaneous transmission of two such frequencies. But, on the other hand, alternative bursts of the two frequencies is not improbable; for example, suppose a cone were to be responding to red and green stimuli simultaneously, then a short burst of 100 nerve impulses per second would be followed by a short burst of 300 nerve impulses per second, and so on in alternation so long as the stimulus lasted. When white light is falling on the retina and, in consequence, according to the trichromatic theory, all three sensations are being aroused, there would have to be alternations of the three frequencies, each lasting for

a short period, and being followed in turn by the remainder.

Now since the type of colour sensation is determined by frequency, it is impossible for intensity of light to be transmitted by any variation in the number of nerve impulses per second sent up the particular nerve fibre. In consequence, it is a corollary of this hypothesis that each cone performs in an all-or-none manner, and that different cones have different thresholds, so that as the intensity of light increases the number of cones responding to that light increases; thus the active cone population will be small when light intensity is small and will increase to a maximum number as light intensity increases. Sooner or later, as this increase in light intensity continues, the whole of the cone population will have been brought into a state of activity, and further increase of light intensity which takes place will not cause a corresponding increase in the intensity of the sensation received by the brain.

The advantages and disadvantages of this theory may be stated as follows.

Since each cone responds to every colour, visual acuity with coloured light should be exactly equal to visual acuity with white light, and this fits in with experimental observation, any variations which are met with in practice being accounted for without difficulty, by variations in the sharpness of the image projected on the retina by the optical system of the eye. Since the number of active cones increases with the increase of light intensity, an explanation is given for the increase in visual acuity which is observed as light intensity increases. This theory also gives a reasonable explanation of the appreciation of variation of light intensity, since the small increase of light intensity is accompanied by an increase in the number of active cones. This theory gives no explanation of the important observations of Styles and Crawford, who found that the directional effect of the retina differed considerably in detail according as red rays, green rays or blue rays were used for the investigation. It would have been expected, on this theory, that the directional effect would have been the same for all colours, since the colours make use of identically the same cones.

The Triple-Cone Hypothesis

According to this hypothesis, every cone of the retina is capable of responding to one colour sensation only. Thus, in the fovea centralis, there must be three different types of cone, those responding to red, those to green, and those to blue. In the more peripheral parts of the retina, however, one of these types of cone, namely the green, may be reduced in number or may be omitted altogether in order to account for the diminution of the colour sense which is found there experimentally.

According to this hypothesis, the brain receives nerve impulses which inform it of the colours present in the image formed on the retina. It is possible that every one of these cones behaves in an all-or-none manner as was suggested by Hecht, but it is also possible that each of these cones responds in a graded manner, sending impulses along the optic nerves which vary in frequency according to the intensity of light which is falling on the cone in question. This view, which was suggested by me, has been supported experimentally by Hartline and others. This theory fits in admirably with the directional effects found by Styles and Crawford, namely that red light, green light and blue light each has a directional effect which differs from that of the others.

An apparent difficulty is met with in connexion with visual acuity which, at first sight, should have a markedly lower value for light of a single colour than is found for white light, since only about one third the number of cones is being stimulated. This difficulty is, however, avoided when it is remembered that in any random distribution of several different populations there are always places to be found where one population predominates over the others. An excellent example of this is the colour screen of the Lumière photographic plate. In this, there are distributed irregularly three different coloured groups of starch grains, red grains, green grains and blue grains. When such a screen is looked at with the naked eye, red, green and blue dots are clearly visible. On examining these dots with a microscope it is seen that they are not due to isolated starch grains but to quite large groups of grains of almost entirely one colour. Now if the cones of different colour response are distributed irregularly in the same way, then we should expect to find places where red cones predominate and other places where green cones are in excess, and other places again where blue cones are nearly exclusively present. In consequence, when high visual acuity is wanted for any one colour, it is possible to obtain it by causing the image of the object in question to fall on a part of the retina where the cones sensitive to that colour predominate. In the case of yellow light, a spot where there is a predominance of both red and green cones with the almost complete exclusion of blue cones would be most suitable for the purpose.

Evidence of Colour-Blindness

As is well known, colour-blind persons usually fall into one of four categories: (1) protonopes, who are red blind; (2) deuteronopes, who are green blind; and (3) tritonopes, who are blue blind; and (4) anomalous trichromats, who have abnormal colour vision which is, however, less severe than that of any of the three classes mentioned above. The first three types are readily explained on the triple cone hypothesis by supposing that the cone responsible for the missing sensation is either entirely absent or is defective, whereas anomalous vision is explained by a partial defect in one of the sets of cones, usually the green. In the case of the single-cone hypothesis, an explanation has to be sought for on the following lines: either there is deficient in the retina a chemical substance capable of absorbing light of the missing colour, or that the cones themselves are unable to respond to the catalytic products of this chemical substance when it has been broken down by the action of light. Of these two alternative explanations, the first seems to be the more plausible and the easier to picture, although it should be pointed out that there is no histological evidence for the deficiency of one particular type of cone in the retinas of colour-blind persons. In consequence, colour-blindness, which might have been expected to differentiate between these two theories and to eliminate one of them, in actual fact fails to do so.

Conclusions

We have seen that there are two rival mechanisms, both of which will provide trichromatic vision. Of these, the one which most closely fits in with the known facts is that which postulates three different varieties of cone, one corresponding to red light, another to green light, and a third to blue light.

OBITUARIES

Mr. James MacLehose, LL.D.

JAMES MACLEHOSE, chairman and managing director of Robert MacLehose and Co., Ltd., printers to the University of Glasgow, died at his home, 5 Heriot Row, Edinburgh, on December 14, 1943. He was born at Glasgow on April 9, 1857, the second son of that James MacLehose, publisher and bookseller to the University of Glasgow, whose name figures frequently in Mr. Charles Morgan's charming book, "The House of Macmillan".

James MacLehose was educated at the University of Glasgow, to which he proved a loyal son, and with which he was intimately associated both as bookseller and publisher for many years, and as printer for a longer period. From 1899 until 1909 he was vice-president of the board of management of the Students' Union. His services to scholarship fall under four heads: his eminence as a printer, his work as an author, his editorship, throughout twenty-five fruitful years, of the *Scottish Historical Review*, and his value as an active member of the board of trustees of the National Library of Scotland, the Advisory Committee on Scottish Records, the Scottish History Society and similar bodies.

He has himself stated that his "firm has endeavoured, not without some measure of success, to take its share in upholding the reputation of Scottish and also of British printing". This modest claim was fully substantiated by the elegance and accuracy of the work produced. He maintained the Foulis tradition in Glasgow. He was proud of the edition of "Hakluyt's Voyages" in twelve volumes, and of "Purchas his Pilgrimes" in twenty volumes, produced almost forty years ago, and, in recent years, of the great edition of Scott's Letters edited by Sir Herbert Grierson and published by Constable and Co. His press was identified with the production of volumes on higher mathematics and with the "development of colour printing and its use in educational and medical books". Its imprint has appeared on innumerable school and university text-books. Furthermore, he was the historian of his craft. His volume, "The Glasgow University Press, 1638–1931", was marked by painstaking research and an unflinching desire to arrive at the truth.

These qualities had been sharpened and burnished by his editorship of the *Scottish Historical Review* (October 1903–July 1928), his greatest contribution to the intellectual life of Scotland. When he retired from the editorship he was presented with an address by a representative committee. The following sentences are culled from that address prepared, it may now be revealed, by the late Sir George Macdonald: "To you and to you alone belongs the credit alike for its sterling character and for the regularity of its appearance. Inspired by a genuine interest in the past of your native country, you have given of your best to foster that interest in others, sparing neither time nor money in furtherance of the cause you have so deeply at heart, and bearing almost alone the burden of the whole undertaking." The address also referred to the *Review* as "that storehouse of knowledge of which you have been at once the architect and the warder".

As chairman of the Books and MSS. Committee of the board of trustees of the National Library, Mr. MacLehose, by voice, pen and personal persuasiveness, did much to arrest the destruction or dispersal of family papers of historical and literary value, and ensured their presentation to, or purchase by, the National Library. He was indefatigable. With every inducement to look back over a past packed with achievement, he was, even in old age, when his sight was dim and his natural force abated, ready to live in the present and work, passionately, for the future. "I must home to work while it is called day; for the night cometh when no man can work" might have been his motto, as it was Sir Walter's. The distinguished art of Sir James Guthrie has brought out, most successfully, this eager, forward-looking, vibrant quality in him.

Mr. MacLehose was capped LL.D. of the University of Glasgow in 1915. He was a fellow of the Society of Antiquaries, and of the kindred body in Scotland. He married Mary, daughter of Alexander Macmillan, and is survived by her and by a son and two married daughters. His elder son fell in action as an infantry officer in the War of 1914–18.

W. R. CUNNINGHAM.

Mr. F. S. Marvin

A HISTORIAN with a keen appreciation of the importance of scientific conceptions in the growth of society and a gift for clear exposition passed away in the person of Francis Sidney Marvin, who died on November 14 in his eighty-first year. Marvin was educated at Merchant Taylors' School and St. John's College, Oxford, obtaining a first in Greats and a second in modern history. After teaching for a time in an elementary school, he became one of H.M. Inspectors of Schools, remaining with the Board from 1890 until 1924 and reaching the grade of staff inspector. His chief interest was in history, and from 1915 onwards he organized many courses of lectures for teachers and others. For the session 1929–30 he occupied the chair of modern history in the University of Cairo. After his retirement he was mainly occupied in writing, and in the organization of branches of the Historical Association, to which he frequently lectured.

In August 1914 Marvin was taking part in a meeting of the London Adult School Union at Jordans when war broke out. Feeling that the conception of world history as a unity was sadly lacking, and that this lack had a part in the bringing about of wars, he planned the "Unity History Schools", which met annually, with few interruptions, until the outbreak of the present War. Until 1922 these were held at the Friends' Woodbrooke Settlement, but the 1923 meeting took place in Vienna, and several subsequent meetings were held in Continental cities. Marvin's planning and direction of these schools was admirable. He was most successful in enlisting experts as lecturers, in encouraging discussion, and in summing up the conclusions. A well-grounded classical scholar, he was devoted to the study of history as a continuing record of man's progress. His knowledge of history was wide, but he made no display of erudition, and his style was clear and simple. Although his training had not been in science, he was remarkably successful in seizing the main trends of scientific thought and discovery, which he followed closely, as was shown by his numerous reviews in NATURE of books on sociology and the history of science.

Two of the Unity History Schools dealt specifically with science: that of 1922, when the subject was "Science and Civilization", and that of 1935, when "Science in the Modern World" was discussed in

Rome in a joint meeting with the History of Science Department of the University of Rome. Most of the symposia were published, and some passed through several editions.

An active member of the small Positivist group, Marvin had adopted Comte's teaching that the ladder of the sciences must be completed by sociology. From Comte, too, he had drawn his conviction of Humanity as an ideal, and in recent years, amidst the apparent breakdown of civilization, he never lost his faith in the ultimate triumph of right over wrong.

Marvin's best-known book was "The Living Past", first published in 1913 and several times reprinted. As a comprehensive survey, in which the development of thought is presented as an essential part of history, this short work is perhaps unrivalled. At a dinner in honour of Marvin's seventieth birthday, at which Gilbert Murray, H. G. Wells and others spoke, tribute was paid to his stimulating influence on the study of history. His other books included "Comte" in the series of "Modern Sociologists", "The Century of Hope", "The New Vision of Man", and "The Nation at School". He took an active part in the work of the Sociological Society and its successor, the Institute of Sociology. He married in 1904 Edith May Beverell, and had two sons.

C. H. DESCH.

WE regret to announce the following deaths:

Dr. Walther Kruse, successively professor of hygiene at Bonn, Königsberg and Leipzig and discoverer of the Shiga-Kruse dysentery bacillus, aged seventy-nine.

Dr. F. L. Pyman, F.R.S., director of research, Boots Pure Drug Co., Ltd., on January 1, aged sixty-one.

Mr. Alfred Sidgwick, a distinguished philosopher and logician, on December 22, aged ninety-three.

NEWS and VIEWS

New Year Honours

THE New Year Honours include the names of a number of scientific workers and others associated with scientific work. The principal honours are as follow:

G.C.M.G.: Sir George Gater, Permanent Under-Secretary of State, Colonial Office.

C.H.: The Right Hon. R. S. Hudson, Minister of Agriculture and Fisheries.

K.C.V.O.: Sir Harold Hartley, chairman of the Fuel Research Board.

Knights: Prof. Ernest Barker, emeritus professor of political science in the University of Cambridge; Prof. J. C. Drummond, scientific adviser to the Ministry of Food, professor of biochemistry in the University of London; Prof. F. L. Engledow, professor of agriculture in the University of Cambridge; Dr. J. J. Fox, Government Chemist; Prof. F. R. Fraser, director-general of the Emergency Medical Services; Mr. W. T. Halcrow, engineering consultant, War Office; Mr. C. R. Lockhart, chairman of the East African Production and Supply Council; Mr. T. R. Merton, scientific adviser to the Ministry of Production, formerly professor of spectroscopy in the University of Oxford; Mr. J. G. Nicholson, deputy chairman, Imperial Chemical Industries, Ltd.

C.B.: Mr. P. N. Harvey, director of statistics and intelligence, Ministry of War Transport, Department of the Government Actuary; Mr. C. Nathan, principal assistant secretary, Ministry of Agriculture and Fisheries.

C.M.G.: Right Rev. Mgr. C. Gagnon, rector of Laval University, Quebec, for services to university education; Mr. E. B. Hosking, chief native commissioner, Kenya; Dr. R. C. Wallace, principal and vice-chancellor of Queen's University, Kingston, Ontario, for services to university education.

C.I.E.: Colonel R. H. Phillimore, superintendent of the Survey of India; Mr. M. Carbery, director of agriculture, Bengal; Sri Pattipati H. Rama Reddi, director of agriculture, Madras; Mr. D. B. Sothers, chief conservator of forests, Bombay.

C.B.E.: Mr. W. A. Akers, a director of research, Department of Scientific and Industrial Research; Prof. C. H. Best, professor of physiology in the University of Toronto, for important medical research; Major R. F. Brebner, chairman of directors, Highland and Agricultural Society; Dr. A. N. Drury, director of the Lister Institute, lately a member of the scientific staff of the Medical Research Council; Dr. W. H. Glanville, director of the Road Research Station, Department of Scientific and Industrial Research; Prof. D. A. L. Graham, professor of medicine and clinical medicine and dean of the Department of Medicine, University of Toronto, formerly president of the Royal College of Physicians and Surgeons of Canada, for important medical research; Dr. H. W. Meikle, H.M. historiographer in Scotland and librarian of the National Library in Scotland; Mr. W. Nairn, president of the Royal College of Veterinary Surgeons; J. M. Stewart, K.C., of Halifax, Nova Scotia, for services to university education and also as coal controller; C. Vaillancourt, of Levis, Quebec, for services to war finance and agriculture.

Royal Society Meeting in India

ON January 3, the Royal Society of London convened a short session at the University of Delhi prior to the opening of the Indian Science Congress by the Viceroy of India, Lord Wavell. This is the first time during the nearly three hundred years of its existence that the Royal Society has held a meeting outside London. Prof. A. V. Hill, who is visiting India in connexion with scientific aspects of the war effort, had been appointed vice-president for the occasion. Thus was he able to convey the greetings and goodwill of the President and Council of the Royal Society to the scientific workers of India. The King, who is Patron of the Royal Society, was represented by the Viceroy. There were Indian fellows of the Royal Society present and a large number of guests. Prof. Hill read greetings from the Prime Minister and General Smuts; also from other British scientific bodies. After his address, two recently elected Indian fellows of the Royal Society, Dr. H. J. Bhabha and Sir Shanti Bhatnagar, signed their obligation to the Society on a sheet of parchment which will be inserted in the Society's Charter Book.

British Cotton Industry Research Association : Sir Robert Pickard, F.R.S.

SIR ROBERT PICKARD has for so long been a figure in scientific and educational circles that his retirement, with the close of 1943, from the directorship of the British Cotton Industry Research Association marks something of an epoch. It is seventeen years since he was appointed to succeed the first director, Dr. Crossley, at the Shirley Institute, and all that time it has been his endeavour and pride to build it up until to-day it is the splendid organization that we know, with a staff of more than three hundred and fifty, including eighty graduates. The Cotton Research Association was Sir Robert's particular interest, the child that he brought to vigorous manhood, but he has been a champion of co-operative research associations in general, and it is a question whether any other man has done more for the movement. He was the first director of the British Leather Manufacturers' Research Association before he went to the Shirley, and he has served besides on the councils of two other research associations. It is good to learn that his retirement does not mean that his services to industrial research will be lost entirely, for, doubtless among other activities, he will still be retained as a consultant by both the Associations he has directed.

Sir Robert's connexion with education goes back years even before his research association days. He has been principal of Blackburn Technical School (1907–19) and principal of the Battersea Polytechnic (1920–27), and he has been a member of the Consultative Committee of the Board of Education, a member of the Senate of the University of London since 1926, and has held the office of vice-chancellor of the University of London. A distinguished chemist, he has also played his part in the councils of his chosen subject, having served as vice-president of the Chemical Society, and as president both of the Royal Institute of Chemistry and of the Society of Chemical Industry.

Dr. F. C. Toy

DR. F. C. TOY, who succeeds Sir Robert Pickard as director of the British Cotton Industry Research Association, has been deputy director since 1930, and it is a source of pleasure that he is thus enabled to continue and extend the work he has shared with his chief. Dr. Toy is a physicist, educated at Launceston College, Cornwall, and University College, London, of which he is a fellow. He is well known in Institute of Physics circles, being a member of the Board, the Institute's representative on the National Committee for Physics of the Royal Society, and also chairman of the Manchester and District Branch. He served in the War of 1914–18 as an officer in the Royal Engineers, mainly on sound ranging, afterwards becoming chief physicist to the British Photographic Research Association, where for ten years he was occupied in fundamental researches on the mechanism of the photographic process.

Dr. Toy firmly maintains this fundamental outlook acquired in his earlier days, and he enters upon his new duties with the conviction, based on the experience of the whole of his research life, that pure, long-range investigations constitute more than ever an essential part of the work of any co-operative research organization. This is heartening knowledge for those who recognize where lies the future welfare of British industry, and their good wishes go with the new director of the Shirley Institute as one who not only has helped to form its high scientific character but also is deeply concerned to uphold it.

Action of the Germans in the U.S.S.R.

ON behalf of the Soviet Scientists Antifascist Committee, V. Komarov, president of the Academy of Sciences of the U.S.S.R., A. Bogomolets, president of the Ukrainian Academy of Sciences, and several members of both academies, have sent a message to the Faraday Society, in the course of which they record some of the devastation which has been the regular accompaniment of the German retreat in the U.S.S.R. "Wherever the German army has been, it has brought death and slavery to the people, and destruction of culture." Prof. Nikolai Burdenko, of the Academy of Sciences, U.S.S.R., who personally investigated the crimes of the Germans in the city and district of Orel, refers to the state of psychological stupor of both victims of the German occupation and of medical men treating them. Referring to the material damage, it is stated that when they retreated from Smolensk, the Germans burned down the Teaching, Nutritional and Agricultural Institutes, destroyed the Finance, Co-operative, and Railway Technical Institutes, and the Institute of Telegraph and Telephone Communications, and looted valuable collections from Smolensk museums. In the town of Staline, they wrecked the Medical Institute and burned down all the buildings of the Industrial Institute where 15,000 students studied. In Kiev, a number of large buildings, among them the University, with its library, museums and laboratories, were destroyed. All the Kiev museums, libraries, archives, laboratories and research institutions were looted, according to Alexander Palladin, vice-president of the Ukrainian Academy of Sciences. Prof. Alexander Brodsky, of the Ukrainian Academy of Sciences, states that the Germans blew up and burned the Mining Institute, with its library, at the University Institute of Applied Chemistry, and looted and destroyed a number of other research institutes at Dnepropetrovsk. Prof. Peter Budnikov, of the Ukrainian Academy, who visited Kharkov, states that the Germans destroyed the Institutes of Applied Chemistry and of Electrotechnical Engineering, and other institutes.

The message was received at the annual general meeting of the Faraday Society, and by the authority of the Council, and at the wish of those members of the Society who were present, the following reply was sent : "The members of the Faraday Society have received your tragic message with horror and profound sympathy. The Society will do its utmost to bring it to the notice of all scientists and intellectuals of the United Nations to the end that civilization shall be protected and justice be meted out to the barbarians. E. K. RIDEAL (President), G. S. W. MARLOW (Secretary)."

Scientific Personnel in the Aircraft Industry

THE seventeenth report of the Select Committee on National Expenditure for the session 1942–43, containing replies from Government departments to recommendations in reports, includes a memorandum by the Ministry of Labour and National Service commenting on the Committee's recommendations in its tenth report, discussing aircraft production, on the supply of scientific and technical personnel. The memorandum states that the facilities available for

training research workers, aeronautical engineers and other technicians are under continuous review by the Technical Personnel Committee. It is agreed that men with postgraduate research and similar qualifications should not be allowed to enter the Forces, except for special commissioned posts, for example, operational research. The allocation and deferment arrangements of the Ministry of Labour are considered to provide ample safeguards for this purpose. A professional engineering or scientific qualification is, however, essential for many commissioned posts in the Fighting Services, and in view of the recommendations of Sir William Beveridge's Committee on the Use of Skilled Men in the Services, it has been recognized that a substantial proportion of technical officers in the Services in charge of maintenance and repair of equipment should possess technical qualifications of a university degree or professional standard together with extensive practical experience. But the numbers thus made available were insufficient. It has therefore been necessary to allocate a substantial proportion of the university output to the Services, and also to withdraw experienced men from industry; many of the latter have been volunteers, and the Ministry is concerned lest the Select Committee's observations should be misunderstood, with unfortunate effect on such volunteering.

Steps have also been taken to increase the supply of men graduating in technical subjects by means of the State bursaries, the intensive Higher National Certificate and the Engineering Cadetship schemes. Courses at universities have been shortened to a maximum of two years and three months (two years and nine months in Scotland), and by these measures the output has been substantially increased since 1941 and will reach a peak in 1944. In view of these shortened courses, the Technical Personnel Committee considers that specialized pre-graduate aeronautical courses could be extended only at the expense of fundamental engineering training. The needs of the industry during the War can best be met by the continuation of the existing pre-graduate engineering courses. Apart from a small number of the most promising men who can benefit by a special postgraduate course in aeronautics, graduates should proceed at once to aircraft establishments or firms where they can specialize and pull their weight at the earliest possible moment.

Health in Industry

A MAJOR problem brought to the fore during this War has been to bridge the gulf between scientific knowledge and its application. The Industrial Health Research Board has, during the last twenty-five years, published more than eighty reports on industrial conditions in relation to the health and well-being of the workers. Unfortunately, the necessity for publishing all the data, so that other workers in this field could know what exactly was the evidence on which the conclusions were based, rendered them of little use to those concerned with organizing industry. To remedy this, pamphlets are to be issued giving the conclusions in more general form, and No. 1, called "Ventilation and Heating; Lighting and Seeing", has just been published (H.M. Stationery Office, price 3*d*).

The first part deals with the need for ventilation, the amount of fresh air required, air movement and its problems, some effects of high temperatures, and the complications due to the black-out. The second part gives the principles of good factory lighting, how to measure light, and how the factory regulations should be interpreted, so as to ensure a good general appearance of cheerfulness as well as sufficient light to see the work. Good lighting alone cannot, however, prevent eye-strain for certain kinds of work, so there is a simple account of the working of the muscles of the eyes and of the relief to be secured by the use of special spectacles. There are illustrations showing different systems of artificial lighting, examples of undesirable as well as desirable systems. One undesirable method is called "Glare and Gloom". The pamphlet contains much useful scientific information expressed in readable form.

Measurements at Radio Frequencies

FOLLOWING the annual general meeting of the Radio Society of Great Britain held on December 18, Dr. R. L. Smith-Rose gave a lecture on "Measurements in Radio Experimental Work". After referring to the part played by amateur observers and experimenters in sciences such as astronomy and meteorology as well as in radio, Dr. Smith-Rose emphasized the importance of carrying out quantitative measurements in an orderly and systematic manner. A brief review then followed of the present position in the national laboratories of Great Britain and the United States, of the absolute electrical standards of current, inductance and resistance, and of the practical working standards which are derived therefrom. Frequency is one of the absolute electrical standards common to all branches of electrical engineering, from the low frequencies of the power engineer to the highest used in the modern applications of radio technique: and it is noteworthy that the precision of frequency measurement far exceeds that attainable in the determination of any other radio or electrical quality. With the possible exceptions of current and voltage, most measurements at radio frequencies, such as impedance, resistance and reactance, are made by reference to direct current or low-frequency standards. The lecture concluded with a brief description of some investigations illustrating the application of certain types of measurements at radio frequencies to the determination of the mode of transmission of electric waves along the earth's surface.

Determination of Polar Diagrams of Radio Antennæ

AN article by H. Paul Williams (*Elec. Comm.*, **21**, No. 2; 1943) describes a machine which enables one to determine a polar diagram in a fraction of the time required by direct calculation. A computation which ordinarily would take a whole day can be performed in fifteen minutes on the machine. In its present version, it will calculate the polar diagram given by as many as five antennæ. These may be situated anywhere within a circle of four wavelengths diameter, while the currents in the antennæ may have any relative phases and magnitudes. The exploring angle is read off from a dial marked in degrees, and the corresponding relative amplitude is shown directly on a voltmeter. As few or as many readings as one likes can be taken, and also one may turn the handle backwards to a previous value if required.

With such a machine there is an appreciable reduction in the possibilities of errors—a feature quite as important as the saving of time. It is now also practicable to consider a large number of variations in a design the working out of which would take a prohibitive time without such a machine. Although

the number of antennæ catered for in the present model is five, the principle of operation will allow for its extension to any number. Moreover, the system could readily be extended for tracing out the polar curve automatically. For this refinement all that is required is a turn-table, which would be operated off the common main shaft, and a recording type voltmeter. The machine has been in constant service for about two years.

The Practice of Spraying

GROWMORE BULLETIN No. 9 ("Orchard Spraying for Commercial Growers". H.M. Stationery Office. Pp. 14. 4*d*. net) condenses a large amount of modern knowledge into useful practical suggestions for the spraying of fruit trees. Much of the text relates to the routine care of equipment in order to avoid replacement during war-time. Adjustment of the angle of spray cone to give good average coverage without wind loss conserves spray fluid and saves time. Modern research stresses the necessity for high-pressure spraying, and the corresponding variations in equipment and practice receive full treatment in the bulletin. Mr. J. Turnbull is the author, and much information about the economics of large-scale spraying is included.

Typhus in Venezuela

THE May issue of the *Boletin de la Oficina Sanitaria Panamericana* contains a note on this subject by Dr. L. Briceno-Iragorry, of the Laboratory of Epidemiology of the Venezuela Institute of Hygiene, who states that the first mention of typhus in Venezuela was in March 1896. Since then several cases have been reported in 1938, 1939, 1940 and 1941. The chief forms of the disease in Venezuela may be reduced to two, the first being named Guacaraja fever, which probably resembles Rocky Mountain spotted fever, and the second being known as benign, endemic or rat-borne typhus. The rat-borne character of this second form of typhus has been demonstrated by the Weil-Felix reaction in the blood serum of patients as well as in rats in the Caracas area.

Chronic Parasitoses in Bolivia

IN a recent paper (*Bol. Of. San. Panamericana*, **22**, 487 ; 1943) Dr. Felix Veintemillas, of the Bolivian Institute of Bacteriology at La Paz, states that no systematic study of chronic parasitoses, such as leishmaniasis, yaws, intestinal parasites, dysentery, Chagas's disease and pinto in the tropical and sub-tropical regions has so far been made, although some progress has been achieved. The Bolivian 'azulejos' has recently been identified with pintos, and the first case of granuloma coccidioides was diagnosed in 1941. So far, however, human cases of Chagas's disease have not been found, but infested vectors have been discovered.

Sir Henry Morris, Bart. (1844–1926)

SIR HENRY MORRIS, an eminent London anatomist and surgeon, was born at Petworth, Sussex, on January 7, 1844, the son of a local surgeon. He was educated at Epsom College, of which he afterwards became treasurer, University College, London, and Guy's Hospital, where he qualified in 1861. He first became attached to the Middlesex Hospital in 1870 as surgical registrar, and afterwards became assistant surgeon, then surgeon and in charge of the cancer wards. In 1871 he was lecturer to the Hospital on practical surgery, and during 1872–81 lecturer on anatomy. He retired in 1905 at the age of sixty. He was a prolific writer. His most important work was "The Anatomy of the Joints of Man", which was first published in 1879 and ran through eight editions. In 1893 he became editor of "A Treatise on Human Anatomy", to which he contributed the section on "The Articulations". This work also went through several editions. Besides numerous articles in medical journals and text-books, he was author of several works on genito-urinary surgery. He held many offices at the Royal College of Surgeons, of which the most important were president (1906–7), Hunterian Orator (1909) and member of the Court of Examiners (1894–1904). He died after a short illness on June 14, 1926.

Announcements

MR. R. W. MARSH, of the Long Ashton Research Station, has been elected president for 1944 of the British Mycological Society.

A SOVIET scientific commission is now in Novosibirsk, organizing a Western Siberian branch of the Academy of Sciences of the U.S.S.R. The Academy will establish four institutes in the city : for chemistry and metallurgy, mining and geology, medicine and biology, and transport and power.

EARL DE LA WARR, chairman of the Agricultural Research Council and director of home flax production at the Ministry of Supply, is making a tour in Canada to speak to audiences throughout the Dominion about the war-time agricultural effort in Great Britain ; he will also visit various agricultural institutions in the Dominion, including research stations.

A LECTURE on a chemical engineering subject has been endowed by Mr. J. Arthur Reavell, and will be given under the auspices of the Institution of Chemical Engineers. It will be known as "The J. Arthur Reavell Lecture", and will be delivered not less frequently than once in every four years.

THE following appointments have been made in the Colonial Service : B. J. Hancock, agricultural officer, Gold Coast ; D. A. McBurney, agricultural officer, Sierra Leone ; C. C. Parisinos, agricultural officer, Northern Rhodesia ; R. M. Palmer, assistant conservator of forests, Sierra Leone ; J. R. G. Watters, assistant conservator of forests, Nigeria ; A. L. C. Thorne, veterinary officer, Gold Coast ; C. A. Cockshott, inspector of plants and produce, Gold Coast ; J. H. Henderson, physiological laboratory superintendent, Nigeria ; E. H. Probyn (assistant conservator of forests, Nigeria), assistant conservator of forests, Sierra Leone.

THE third conference on "X-Ray Analysis in Industry" has been provisionally arranged to take place in Oxford on March 31 and April 1 under the auspices of the X-Ray Analysis Group of the Institute of Physics. Particulars can be obtained from Dr. H. Lipson, honorary secretary of the Group, c/o Crystallographic Laboratory, Free School Lane, Cambridge. The conference will be open to all interested, but it may be necessary to limit the number of non-members of the Group for whom accommodation can be provided.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Recognition of a Further Common *Rh* Genotype in Man

SINCE the publication of a recent communication[1] on the subject of *Rh* genotypes certain advances have been made. The point had been reached, as described in that communication, where by the use of three different forms of anti-*Rh* sera, the genotypes of about 68 per cent of the population could be recognized, and five allelomorphs could be distinguished. Since then we have found a serum, described at a meeting of the Royal Society of Medicine on November 2, 1943, which, when used in combination with the other three, makes recognizable the genotype of about 80 per cent of people and defines two further allelomorphs, making seven in all. More recently a letter (see below) has come from Wiener describing all these allelomorphs except *Rhy*. We will use Wiener's names, which are Rh_1, Rh_2, *rh*, *Rh′* (*rh* dot), *Rh″* (Rh_x), but for the gene Wiener calls *Rh* (Rh_1 bar) we prefer Rh_0, for *Rh* has for so long had a much wider meaning. The names we have used[1] and are now abandoning are given in brackets. *Rhy* we will continue to use.

The new serum agglutinates the red cells of people who have the frequent gene Rh_1 or the rare gene *Rh′*. It is undoubtedly the type of serum called by Wiener[2] anti-Rh_1. Perhaps its greatest use is in separating the genotypes Rh_1Rh_2 (12 per cent), Rh_1Rh'' (1 per cent) and Rh_2Rh' (0·2 per cent) from the serologically indistinguishable group called "the rest" in our previous communication. "The rest" group now contains only Rh_2rh (12 per cent) and Rh_2Rh_2 (2 per cent) of common genotypes while, ignoring the rare ones, the genotypes of about 80 per cent of people can be recognized.

We were first made aware of the existence of the forms Rh_0 and *Rh′* when the blood of 154 unselected donors was tested with *Rh St KJ* and anti-Rh_1 sera. Of these, 57 gave the reaction of Rh_1rh (+ + –), all of them being positive with the new anti-Rh_1 serum except one. The presumption that the factor responsible for this unexpected reaction, now called Rh_0, is allelomorphic is supported by its occurrence in two generations of a family (father *rhrh*, mother Rh_0rh, daughter Rh_0rh). Rh_0rh cells give the double dose effect[1] when titrated with *St* serum, showing that Rh_0 is *St*+. Twenty of the 154 bloods gave the reaction of *rhrh* (– + –); of these all were negative with the anti-Rh_1 serum except one; the gene responsible for the exception is now called *Rh′*. In one family (No. 15, Race *et al.*[3]) this allelomorph has been found in two generations (mother's sister *Rh′rh*, mother *Rh′rh*, father Rh_1rh, first child Rh_1rh, fourth child *Rh′rh*). *Rh′rh* cells give the single dose effect when titrated with *St* serum, showing that *Rh′* is *St*–.

The total number of unselected bloods examined with *Rh*, *St* and *KJ* is now 435, and the last 154 of these have also been tested with the anti-Rh_1 serum. This latter serum is supporting the general theory put forward in the previous communication, for in the group *Rh*+*St*+*KJ*+ called "the rest", it can be calculated that 47 per cent should have either the gene Rh_1 or *Rh′*. In the 154 bloods there were 48+++, and of these 20, or 42 per cent, were positive with the anti-Rh_1 serum ($\chi^2 = 0{\cdot}49$ for 1 *D.F.* Probability about 0·5).

The results with the three sera are:

	– + –	+ – –	+ + –	– + +
Mainly	*rhrh* (96%*)	Rh_1Rh_1 (96%)	Rh_1rh (97%)	*Rh″rh* (97%)
	75	75	149	4
Per cent	17 24	17·24	34·25	0 92

	+ – +	– – –	+ + +	Total
Mainly	Rh_1Rhy (100%)	*Rh′Rh′* (100%)	The rest	
	3	0	129	435
Per cent	0 69	0	29·66	

* The figure in brackets shows, in the first case for example, the percentage of bloods reacting – + – which are in fact *rhrh*; the remaining 4 per cent are *Rh′rh*.

The gene frequencies given in the previous communication need slight alteration. Before calculating the frequency of *rh*, a deduction must be made from the 17·24 per cent – + – bloods, since one person in 154, or 0·65 per cent, previously thought to be *rhrh*, is now known to be *Rh′rh*. The gene frequency of *rh* is $\sqrt{0{\cdot}1724 - 0{\cdot}0065} = 0{\cdot}4073$; $Rh'rh = 0{\cdot}0065$; therefore $Rh' = \dfrac{0{\cdot}0065}{2 \times 0{\cdot}4073} = 0{\cdot}0080$. The frequency of Rh_1 can be calculated from the + – – group, of which Rh_1Rh_1 makes up 96 per cent, the remaining 4 per cent consisting of Rh_1Rh' (see Table 2), consequently:
$(Rh_1)^2 + 2(Rh_1Rh') = 0{\cdot}1724$, and since $Rh' = 0{\cdot}0080$, then $Rh_1 = 0{\cdot}4073$, by chance the same as *rh*. $Rh_1Rhy = 0{\cdot}0069$.

$$\therefore\ Rhy = \frac{0{\cdot}0069}{2 \times 0{\cdot}4073} = 0{\cdot}0085;\quad Rh''rh = 0{\cdot}0092$$

$$\therefore\ Rh'' = \frac{0{\cdot}0092}{2 \times 0{\cdot}4073} = 0{\cdot}0113;\quad Rh_0rh = 0{\cdot}0065$$

$$\therefore\ Rh_0 = \frac{0{\cdot}0065}{2 \times 0{\cdot}4073} = 0{\cdot}0080,$$

and by difference $Rh_2 = 0{\cdot}1496$.
Based on these gene frequencies, the expectation for the group + + – and for the group called "the rest" can be calculated, and the theory tested by comparison with observation.

	+ + –	"The rest"
Expected	34·50%	28 63%
Observed	34 25%	29·66%

The frequency of the commonest six genotypes as calculated from our sample are given below. These frequencies are only approximate for the community as a whole, the proportion of *Rh* negative being slightly higher than we have found in a much larger sample.

TABLE 1.

	Per cent	*Rh*	*St*	*KJ*	Rh_1
rhrh	16·59	–	+	–	–
Rh_1Rh_1	16·59	+	–	–	+
Rh_1Rh_2	12·19	+	+	+	+
Rh_1rh	33·18	+	+	–	+
Rh_2rh	12 19 }	+	+	+	–
Rh_2Rh_2	2·24 }				

These total 93 per cent; the remaining 22 rarer genotypes make up 7 per cent, and ignoring these we are able to distinguish serologically between all the 93 per cent, except that we cannot make the distinction between Rh_2rh and Rh_2Rh_2. Examination of thirty families has so far revealed no exception to this scheme of allelomorphs.

This was the state of our work when a letter, dated October 11, 1943, came from Wiener enclosing the typescript of a paper then in the press, in which is described the behaviour of six allelomorphs of the *Rh* gene. In Table 2 is a comparison of Wiener's scheme and our own:

Table 2.

Wiener Antisera Genes	Rh	(St)	Rh_2	Rh_1	Rh'	Rh''
Rh_1	+	0	—	+	+	+
Rh_2	+	0	+	—	+	+
Rh	+	0	—	—	+	+
Rh'	—	0	—	+	+	—
Rh''	—	0	+	—	—	+
rh	—	0	—	—	—	—

Race, *et al.* Antisera Genes	Rh	St	KJ	Rh_1
Rh_1	+	—	—	+
Rh_2	+	+	+	—
Rh_0	+	+	—	—
Rh'	—	—	—	+
Rh''	—	+	+	—
rh	—	+	—	—
Rhy	?	—	+	?

The two schemes show complete agreement, save that Wiener has not met the Rh_y allelomorph because he has not had an *St* serum. The results are so strikingly similar that the probability of their being correct must be very high. We were stimulated by Wiener's letter to attempt to identify his types of sera with those we have used, and have found all of them represented in our collection. Among sera which have occasionally given anomalous reactions, we have been able to identify anti-Rh' and anti-Rh''. That we had not employed these two types of serum regularly does not seem to matter since the distinctions they make are already made by anti-*Rh*, *St*, *KJ* and anti-Rh_1. The great value of *St* serum is made clear, for ignoring those that are very rare, it raises the proportion of people whose genotypes are recognizable from approximately 30 to 80 per cent. While these schemes cover the great majority of our findings occasional anomalous results suggest that other very rare forms may exist.

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Dec. 1.

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[3] Race, Taylor, Cappell and McFarlane, *Brit. Med. J.*, 2, 289 (1943)

Phenogenetic Evidence for the Amphidiploid Origin of New World Cottons

THE genus Gossypium may be divided cytologically into four main groups :

(1)	Asiatic diploids	($n = 13$)
(2)	American diploids	($n = 13$)
(3)	Australian diploids	($n = 13$)
(4)	New World 'tetraploids' .. .	($n = 26$)

Cytological evidence[1,2] suggests strongly that New World cottons have been evolved by amphidiploidy from hybrids between Asiatic and American diploid cottons. It is supported by artificial syntheses of amphidiploids which produce partly fertile hybrids when crossed with New World types[2,3]. Phenogenetic evidence leading to the same conclusion is presented here.

It is known that Asiatic and New World cottons each have a series of multiple alleles which control the shape of the leaf. That a similar series occurs in American diploid cottons is highly probable, though critical data are not yet available. If New World cottons are amphidiploids of Asiatic × American diploid parentage they should have (at least initially) *two* leaf-shape loci, one homologous with the Asiatic alleles, the other homologous with the corresponding series in American diploids. Phenogenetic studies of the action of the leaf-shape alleles on the development of the leaf led to the suggestion[4] that the joint action of an entire (unlobed) leaf gene from the

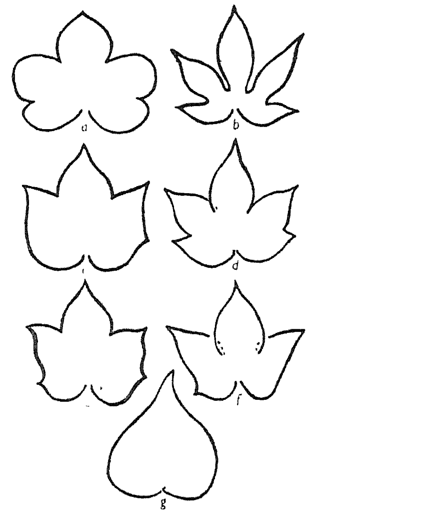

Fig. 1. TOP ROW ASIATIC PARENTS, (*a*) *l* (*herbaceum*), (*b*) L^A (*arboreum*); SECOND ROW: ASIATIC × AMERICAN F_1s, (*c*) *l* × *raimondii*, (*d*) L^A × *raimondii*; THIRD ROW: NEW WORLD AMPHIDIPLOIDS, (*e*) *l* (*hirsutum* VAR. *taitense*); (*f*) L^E (*barbadense* VAR. *darwinii*); BELOW: AMERICAN PARENT, (*g*) *raimondii*.

American diploid parent and a lobed leaf allele from the Asiatic parent might reproduce a type of leaf development which is characteristic of New World cottons. In other words, the New World allelomorph series might be regarded as a series of Asiatic alleles acting in conjunction with an entire leaf gene at the other locus. No duplicate leaf-shape genes are known in New World cottons, so it was postulated, on this hypothesis, that the entire leaf gene is quite stable and common to all New World cottons.

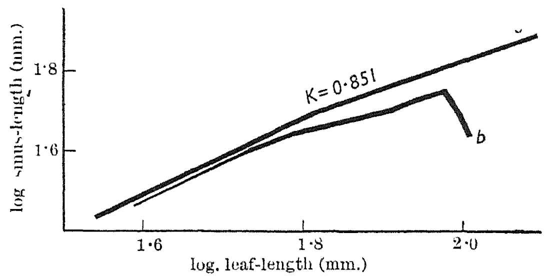

FIG. 2. DEVELOPMENTAL TRACKS OF ASIATIC × *raimondii* F_1 HYBRIDS: (*a*) *l* × *raimondii*, (*b*) L^A × *raimondii*.

Crosses between Asiatic and American diploid cottons very rarely set viable seeds (less than 0·5 per cent in my experience). However, two hybrids have so far been obtained :

	Asiatic		American
(1)	*G. arboreum* (L^A)	×	*G. raimondii*
(2)	*G. herbaceum* (l)		

The symbols refer to the leaf shape alleles carried by the Asiatic parents. The American species has entire leaves. Leaf outlines of the parents and hybrids are compared with standard New World types in Fig. 1. It can be seen that the leaves of F_1, L^A × *raimondii*, and F_1, *l* × *raimondii*, show a marked resemblance to the New World L^E and *l* leaf types, respectively. This resemblance is not a chance superficial one since the course of development is remarkably similar. Developmental tracks* of the F_1 compounds closely resemble those of the corresponding New World types (Figs. 2 and 3). The corresponding *l* × *raimondii* (Fig. 2) and *l* (Fig. 3) tracks are almost linear and

* Graphical representations[4] of the progressive change in leaf shape from node to node during the juvenile stages.

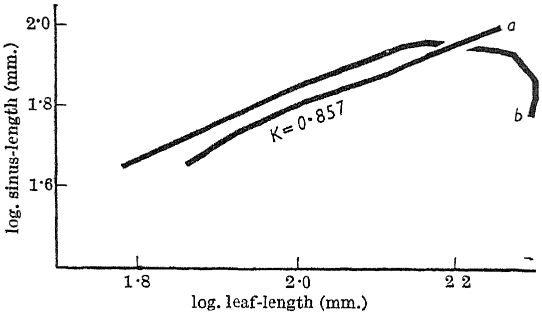

FIG. 3. DEVELOPMENTAL TRACKS OF NEW WORLD AMPHIDIPLOID TYPES: (a) *l*, (b) L^E. COMPARE WITH SYNTHESIZED TYPES IN FIG. 2.

can therefore be expressed as allometric developmental constants (K values). As shown in the figures, the two K values are practically identical.

Subject to confirmation by orthodox genetic analysis—which awaits the successful synthesis by colchicine treatment of a set of amphidiploids which will cross with New World types—the data suggest that two alleles of the New World series, L^E and l, are identical with $L^A + X$, $l + X$ respectively, where X is an entire leaf allele from an American diploid entire leaved ancestor. Four American diploid species with entire leaves still exist: *G. aridum*, *G. armourianum*, *G. klotzschianum* (including *davidsonii*) and *G. raimondii*. General morphological considerations suggest that either of the two last-named in combination with *G. arboreum* would produce a hybrid showing considerable similarity to present-day New World cottons.

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Acid-labile Carbon Dioxide in Mammalian Muscle and the Hydrogen Ion Concentration of the Muscle Fibre

FOR the isolated sartorius muscle of the frog it was found[1] that over a wide range of concentration of external potassium and chlorine ions the following relation applied (in accordance with the Donnan principle):

$$\frac{[K]_1}{[K]} = \frac{[Cl]}{[Cl]_1},$$

where $[K]_1$,$[K]$ are the potassium concentrations within and without the fibre, and similarly for [Cl]. It may be assumed that the following would likewise apply:

$$\frac{[K]_1}{[K]} = \frac{[H]_1}{[H]} = \frac{[Cl]}{[Cl]_1} = \frac{[HCO_3]}{[HCO_3]_1}$$

since H is a smaller cation than K, and HCO_3 about the same size as Cl.

Recently Wallace and Hastings[2] published data for the total carbon dioxide in mammalian muscle, finding therein about 11 mM. carbon dioxide per kilo —and allowing the free carbon dioxide to be in approximately equal concentration across the membrane, and the remainder to be altogether HCO_3 ion, it follows that the ratio $\frac{[HCO_3]_1}{[HCO_3]}$ would then be far higher than $\frac{[K]}{[K]_1}$. Therefore, either the mammalian muscle fibre has a much different electrolyte distribution and a different membrane permeability than frog muscle, or the fraction of the total carbon dioxide assigned by Wallace and Hastings to the HCO_3 ions is much too high.

The latter is the true explanation, as shown in recent work in this laboratory. The total carbon dioxide in mammalian muscle was determined by extraction in alkali solution and subsequent measurement of the carbon dioxide liberated on acidification. The figure of Wallace and Hastings was confirmed. It was found, however, that if to the alkaline extract saturated barium chloride was added, and the mixture centrifuged for about 90 minutes at 3,000 rev./min., in many cases a clear solution was obtained, and this contained more than half the total acid-labile carbon dioxide. The leg muscles of very young rabbits, and the abdominal muscle in general, were found to be the most satisfactory for the purpose.

For rabbit abdominal muscle the total carbon dioxide was found to be 11·4 mM. per kilo and the barium-soluble fraction 5·2. For the leg muscle of rabbit and cat the total was found to be 10·6 and the barium-soluble fraction 7·0 mM. per kilo. The reality of a true barium-soluble fraction of such magnitude was proved by the following facts. (*a*) Additions of HCO_3 (as potassium bicarbonate) to the alkali extracts before addition of barium chloride were fully precipitated. (*b*) A curve of turbidity against HCO_3 present before addition of barium chloride was obtained by first evacuating abdominal muscle for hours in the cold, and then extracting with alkali, and adding graded amounts of HCO_3 to similar volumes of extract. The turbidity on adding the barium chloride was measured in the Pulfrich turbidimeter, and expressed in absolute numbers. A value of 0·10 in the extract would about correspond to the barium-soluble carbon dioxide in extract of fresh muscle, whereas either no opacity was present after the barium chloride addition and centrifuging (90 min.) or so little that the total average value was 0·008, or only 8 per cent of the turbidity for the equivalent amount of HCO_3.

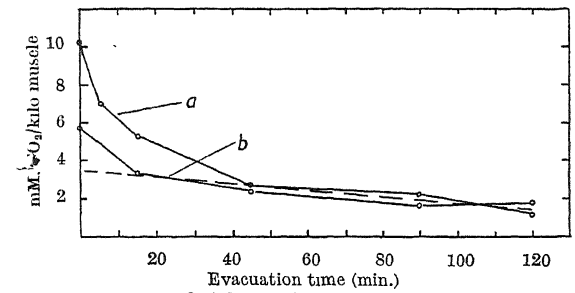
Nature of the barium-soluble fraction. From the researches of Henriques[3], Faurholt[4], Meldrum and Roughton[5], it might be expected that some at least of this barium-soluble fraction is carbamino carbon dioxide. We have investigated the time curve of carbon dioxide loss from evacuated guinea pig muscle, and obtained the mean curves as shown in the accompanying figure. It will appear that a 2–3 mM. fraction only of the barium-soluble quantity is given off rapidly, and the greater fraction, 3–4 mM. per kilo, is emitted very slowly. Only 2–3 mM. can therefore be regarded as likely to be carbamino carbon dioxide, the remainder being a still unknown compound.

The pH in the muscle fibre. The free carbon dioxide plus the HCO_3 ion in leg muscle is $10·6 - 7·0 = 3·6$, and allowing for the interspace values, etc., the true value of the bicarbonate content in the water of the muscle fibre becomes 0·9 mM. per litre, whereas the carbon dioxide in the extracellular water is approximately 1·2 mM. per kilo. Therefore the pH is given by

$$pH = 6·1 - \log 1·2/0·9 = 6·0.$$

If, on the other hand, we consider the ratio

$$\frac{[K]_1}{[K]} = \frac{[H]_1}{[H]},$$



a. Total acid-labile carbon dioxide.
b. Barium-soluble fraction.

and that $[K] = 5{\cdot}5$, and $[K]_1 = 157$, then since the [H] of serum is $10^{-7{\cdot}42}$, we obtain in turn that the value of $[H]_1$ is $10^{-6{\cdot}0}$, or the pH $= 6{\cdot}0$.

In another communication Wallace and Lowry have brought evidence, as they believe, for the non-diffusibility of HCO_3 ion across the muscle membrane. Such experiments are readily interpreted both from the principles outlined for electrolyte equilibria across the muscle fibre membrane and discussed at some length in the *Journal of Physiology* of 1941[6], and the findings here described.

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P. J. FEARON.

Biochemical Laboratory,
University College,
Dublin. Oct. 25.

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Nitrogenous Manuring of Black Cotton Soil

RAIN-FED cotton is the principal money crop of the black soil tracts of India[1], which are often characterized by low yields and where nitrogen alone, among the three fertilizer elements nitrogen, phosphorus and potassium, has been found to be essential for increasing the yield[2]. Groundnut cake, ammonium sulphate and farmyard manure or compost have all given significant response, the expected increases in yield in pounds of seed cotton per acre for unit dose of nitrogen being $3{\cdot}79 \pm 0{\cdot}22$, $2{\cdot}24 \pm 0{\cdot}17$ and $1{\cdot}19 \pm 0{\cdot}17$ respectively.

Humic manures are slow-acting and do not, in consequence, compare favourably with other nitrogenous manures and fertilizers, at any rate in their immediate effect[3]. But the regular superiority of groundnut cake over ammonium sulphate, even on the immediate crop and, in spite of its slight but significant adverse effect on germination[4], was rather unexpected and warranted further examination. It has since been ascertained that application of groundnut cake and ammonium sulphate to the black, alkaline soil is followed by a certain amount of loss of ammonia, this loss being much more pronounced with ammonium sulphate than with the oilcake. It has been possible to measure, from time to time, the loss of gaseous ammonia *in situ* in field plots by a modification of the technique worked out by Subrahmanyan[5]. Thus, in plots treated with ammonium sulphate and oilcake at 80 lb. nitrogen per acre, the average loss of ammonia from random spots, over a period of 52 days, amounted to 35 and 19 mgm. respectively, the corresponding loss from untreated plots being 12 mgm. In similar experiments carried out in the laboratory, from 12·6 to 24·2 per cent of added nitrogen as ammonium sulphate could be accounted for through loss as gaseous ammonia during a period of a month, whereas, with groundnut cake, under identical conditions, the loss of ammonia ranged only from 8·1 to 16·5 per cent of the added nitrogen.

It would follow, therefore, that a given rate of application of ammonium sulphate would be less effective than its equivalent, on nitrogen basis, of groundnut cake by the extent of its increased loss of nitrogen as ammonia. An observation of interest was that loss of ammonia was considerably less where the ammonium sulphate or oilcake was drilled in furrows instead of being broadcast as is usually the case; such drilling or application at lower depths below the surface was also followed by higher increases in yield[6,7].

Loss of nitrogen from the soil through volatilization as ammonia has been noticed earlier[8,9] and would appear to be a general phenomenon with all tropical soils; indeed, under certain conditions, most of the nitrogen added as ammonium sulphate may be lost in this form within a fortnight[10]. The high alkalinity (pH frequently greater than 9·0) and lime status (replaceable calcium about 40 M.E.) of the black soil would doubtless favour heavy losses of ammonia from this soil, especially with high concentrations of added ammoniacal fertilizers. For this soil, therefore, it is possible that calcium nitrate may prove superior to ammonium sulphate, as has been found to be the case in the Sudan[7].

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Institute of Plant Industry,
Indore. Oct. 29.

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Nature of the Acid in Soft Water in Relation to the Growth of Brown Trout

As the owner of freshwater fishings in the north of Scotland, I am interested in the growth of brown trout. After making a pH survey of the waters in this area, it soon became evident that this pH reading was of very little use without knowing the factors which determined it, in Nature. Not wishing to be guilty of over-simplification or generalization, I would make it clear that these notes only refer to the natural acid waters as they occur here.

These waters are remarkable for the small quantity of minerals in solution, in many cases not exceeding 2 parts per 100,000. They normally consist of carbonates and bicarbonates of the calcium-magnesium group. I shall refer to this as the calcium content, which is the first of the two controlling factors.

The second is the amount of carbon dioxide in solution. A neutral water, pH 7, under the limitations

above, exists when the calcium content balances the carbon dioxide in solution. An acid or soft water is one in which carbon dioxide is in excess, and conversely a hard or alkaline water has an excess calcium content.

It will be objected that no mention is made of any other acid, mineral or organic. I maintain that there is no proof that any such acid exists in these waters. The generic term 'humic' acid is just a cloak for our ignorance. A. C. Gardiner, I understand, thought that there was a group of such acids, but that they could not be analysed and that they were too weak to effect ionization and consequently did not alter the *p*H. I can find no proof of this view—in fact, many analyses done for me by him appear to contradict it. In any event, if these hypothetical acids are so weak that we cannot detect them, I hold that we may neglect them as not having any possible effect on the ecology of the trout or its food.

During recent investigations (1939–42) a series of tests have been made on the following lines : (*a*) The *p*H of the sample was determined by the colorimetric test and checked by the electrical method. (*b*) Carbonate stability* was ascertained by adding a small quantity of finely powdered chalk to a part of the sample. (*c*) Air free from carbon dioxide was blown through the sample, thus removing the carbon dioxide in solution. (*d*) The *p*H was taken after removal of carbon dioxide. (*e*) The alkalinity of the water, after carbon dioxide had been removed, was determined and reckoned as parts of calcium carbonate per 100,000.

It should be noted that in every case carbonate stability was higher than the alkalinity, and that in no case was any carbonate taken up after the carbon dioxide had been removed. The *p*H was invariably greater than 7 after carbon dioxide had been removed. These facts would appear to indicate that carbon dioxide and not an organic acid is responsible for the initial low *p*H. This conclusion can only be negatived by assuming that the organic acid is too weak to affect the *p*H or to dissolve the powdered calcium carbonate—for which assumption there is no proof; nor if there were, would it be likely to affect the point at issue, namely, the growth of trout. The following table gives a few typical examples, including one of relatively high calcium content.

Sample	Initial *p*H	After CO_2-removal (*p*H)	Alkalinity	Carbonate stability	Uptake of carbonate after CO_2-removal
A	6·0	not read	2·0	3·4	Nil
B	6·2	7·2	2·2	2·6	,,
C	6·2	7·4	2·7	3·4	,,
D	6·0	7·1	1·3	1·8	,,
E	6·6	7·6	10·8	14·1	,,

One of the most frequent causes of acidity is sphagnum moss. If a quantity of this moss is introduced into a neutral or slightly alkaline water, it rapidly produces an acid reaction. This experiment may be repeated a number of times by squeezing the moss nearly dry by hand and adding it to fresh alkaline water, which is in turn made acid. If my theory, is correct, this acidity is produced by carbon dioxide.

Another frequent characteristic of these acid waters is a brown peaty colour, although this is by no means always so. This colour may be largely removed by filtration through fine sand and is due, I believe, to solids in suspension.

The mere presence of acidity due to excess of dissolved carbon dioxide is no bar to the more delicate forms of life. For example, *Gammarus pulex* is found thriving in waters of both high and low alkalinity with an excess of carbon dioxide giving a *p*H less than 6·6.

The result of this investigation might be that we should cease to regard acidity as the inhibiting factor in the quick growth of brown trout, and search rather for some deficiency in these waters. After investigating the question as regards iodine and phosphorus, A. C. Gardiner came to no definite conclusion, and to conclude I would like to quote him[1], whose mastermind we so sadly miss. "The basic question is, why are the trout in these waters so small ? I am all too conscious that there is nothing very helpful in this article, but it may perhaps start a train of thought which, after the war, will result in the launching of an experiment specifically aimed at finding out why."

R. E. SAWYER.

Highland Club, Inverness.

[1] *J. Salmon and Trout Assoc.*, Jan. 1943.

* Carbonate stability is the maximum weight of carbonates, reckoned as parts of calcium carbonate per 100,000, which the water will hold in solution. It is the final alkalinity of the water determined after adding finely powdered chalk.

Detection of the K_α Satellites on X-Ray Powder Photographs

IN the course of recent research on iron-silicon ferritic alloys, a very faint extra line appeared on X-ray powder photographs taken with iron or chromium radiations. The line appeared close to a strong reflexion of high order. The assumption that it was due to an extra phase was eliminated by the fact that the line still appeared when pure elements were used as specimens.

It was then suggested by Dr. H. Lipson that this line could be due to the 'non-diagram' X-ray emission[1], and this has proved to be a satisfactory explanation. To support it, a photograph of carbonyl iron taken in a 19 cm. diameter camera with chromium radiation ($\lambda_{K\alpha 1} = 2{\cdot}28500$ kX. and $\lambda_{K\alpha 2} = 2{\cdot}28889$ kX.) was measured and the wave-length corresponding to the extra-line appearing with the 211 doublet was found to be 2·2736 kX. This is in good agreement with the values published by Parratt[2], who made an

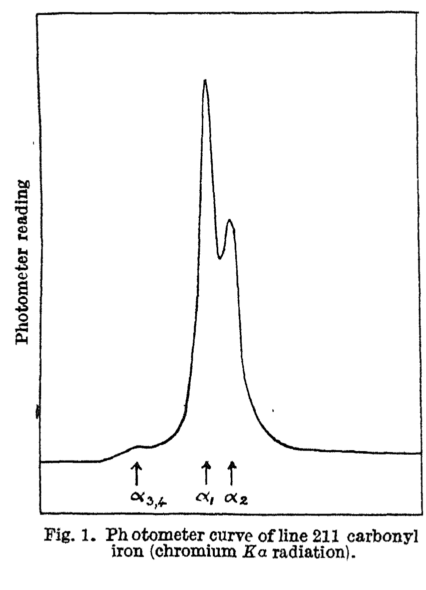

Fig. 1. Photometer curve of line 211 carbonyl iron (chromium $K\alpha$ radiation).

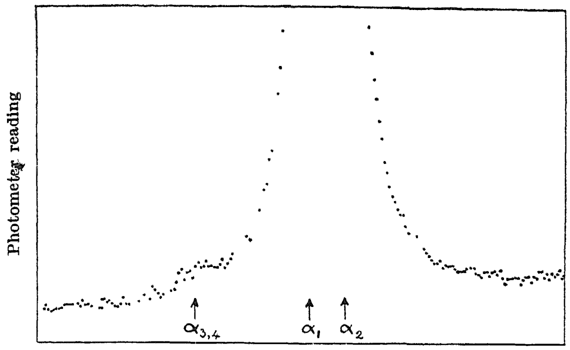

Fig. 2. Experimental points from which Fig. 1 is derived.

extensive study of the $K\alpha$ satellite lines by means of a double spectrometer and an ionization chamber. He found four components for the $K\alpha_3\alpha_4$ group, the two principal ones for chromium having the following wave-lengths: $K\alpha_3 = 2 \cdot 27443$ kX.; $K\alpha_4 = 2 \cdot 27290$ kX. The photometry of the 211 lines confirms the presence of this extra reflexion, as shown by Figs. 1 and 2.

We have detected also the $K\alpha_3\alpha_4$ group with nickel, cobalt and iron radiations, using specimens of pure elements which give a strong high-angle reflexion. The line was weaker with the shorter wave-lengths, in agreement with Parratt's data[2].

To the best of our knowledge, this is the first time that the $K\alpha_3\alpha_4$ group has been definitely detected on powder photographs. The possibility of the appearance of this reflexion, the intensity of which is about 1/100 of the intensity of $K\alpha_1$, should be borne in mind when strong high-angles lines occur on X-ray photographs.

We wish to thank the Director-General of Scientific Research and Development, Ministry of Supply, for permission to publish this note.

MARGARET C. M. FARQUHAR.
ADRIENNE R. WEILL.

Cavendish Laboratory,
Cambridge. Dec. 11.

[1] Siegbahn, "Spektroscopie der Rontgenstrahlen" (Julius Springer, 1931). Compton and Allison, "X-Rays in Theory and Experiment" (D. van Nostrand Co., Inc., 1935).
[2] Parratt, *Phys. Rev.*, **50**, 1 (1936).

Post-War University Education

WHILE possible changes in university education after the War are being considered, I should like to urge the importance of one problem which has hitherto obtained little prominence. Anyone who had much contact with students before the War could not fail to be impressed by the specialized nature of most of their knowledge. For example, a graduate in classics was often completely ignorant of scientific thought, while a graduate in any of the sciences, as a rule, knew little of humanistic subjects beyond some French and German. Moreover, there is little doubt that this increasing departmentalization of the universities was encouraging the tendency, so disastrous at the present time, whereby what is scientific is divorced from humanistic purposes. The regulation at some universities compelling an honours student to take one or two classes outside his honours group, while good in theory, fails in practice, because these other classes are much too narrow in their aims and are, in fact, often the first-year courses for students who propose taking honours in them.

How can this be remedied ? It would be a retrograde step to decrease the specialization of the honours groups, and the proposal of the British Association Committee on Post-War University Education to introduce a new honours group, called "philosophy, natural and social", does not solve the present difficulty, namely, how students, in honours groups which already exist, can acquire a more balanced and mature mental outlook.

The best solution, it seems to me, is the introduction of a course dealing with what is called in the United States "The History of Ideas". Such a course would deal with the growth and development of conceptions which play a great part in our intellectual life to-day—conceptions such as individual freedom, social equality, scientific law, moral obligation, evolution, the nature of scientific method, and so on. At universities where attendance at lectures is, to some extent, compulsory, I should like to see such a course compulsory for all honours students in the year before they sit for their final examination. They would at this stage be more mature than freshmen and yet not be under the strain of working for their degree examination. At universities where attendance at lectures is entirely voluntary, I should like to see those students who did not attend the course compelled to take the examination in it, so that they would at least have been forced to read books like Whitehead's "Science and the Modern World" and Coulton's "Medieval Panorama", and to discuss some of the problems raised by them under the guidance of a tutor. I am urging this step for honours students only. Undergraduates who are reading for a pass degree are at present able to study a considerably wider range of subjects, and the problem is therefore not so pressing for them. Besides, it is most necessary that those who are intellectually the most able should have this broad background against which they can set their own specialized activity.

If the desirability or, as I should prefer, the necessity of such a course is admitted, it would not be difficult to organize it. The best means, I think, would be for it to be given in university departments of education. At present such departments give courses on the history of education, and while these cover to some extent the rather dry topics dealt with by text-books appearing under that title, they deal mainly (or should deal mainly) precisely with the history of those ideas which have had a great influence on the development or education of mankind. It would no doubt mean that the departments concerned would have to make some domestic alterations, but it does not seem that any fundamental changes would be necessary.

It may be objected that the numbers for such a course would be much too large. If that is so, it might be necessary for a few years to limit the number taking it until a large enough staff could be obtained to deal with them. But that is certainly not a permanent objection. I understand, although I have no direct knowledge, that a few years ago it was made compulsory for all Harvard undergraduates to take a course in American history. It seems to me the time is now ripe for all British undergraduates, of sufficiently high intellectual capabilities, to learn the history, not of this or of some other nation, but of what is common to all nations—the ideas which are the basis of the modern world.

C. D. HARDIE.

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RESEARCH ITEMS

Scraggly and Ataxic Pigeons

O. Riddle and N. F. Hollander have described (*J. Hered.*, **34**, 167; 1943) two recessive characters, scraggly and ataxia, in their cultures of pigeons. Scraggly squabs show crusty and flaky skin homologous to ichthyosis in man, and the feathers appear more slowly than normal and do not interlock. Flight is impossible with these hairy-like feathers, which also do not protect the bird from cold. Scraggly behaves as a normal Mendelian recessive in inheritance and shows no linkage with several other characters. Ataxia has been followed for twenty-eight years. It causes the bird to show several inco-ordinations in behaviour; nodding of the head, unsteady gait, somersaulting, irregular flight and sitting on its tail. Histological examination indicates that myelination in the nervous system is reduced and differences in chemical constitution of the cerebrum-medulla segments of the brain are marked. The condition in pigeons has points of similarity with Friedrich's and with Marie's ataxias in man. Ataxia in pigeons is inherited as a Mendelian recessive, but the inheritance is irregular.

Fibrinogen

A CURIOUS property of fibrinogen not exhibited by other serum proteins has been discovered by L. B. Jaques (*Biochem. J.*, **37**, 344; 1943). Study of the clotting of purified fibrinogen by thrombin required, in order to obtain samples for analysis, a method of stopping the reaction quickly which would not affect the solubilities of fibrin and fibrinogen. When dilute iodine, potassium permanganate and potassium dichromate were tested for this purpose they were found to give heavy precipitates with fibrinogen. Both iodine and hydrogen peroxide were reduced by fibrinogen, although with hydrogen peroxide precipitation occurred only in the region of the isoelectric point. This characteristic reduction of iodine and hydrogen peroxide by fibrinogen indicates a further example of the non-sulphydryl reducing groups of proteins studied by Anson and Mirsky. The nature of this group in fibrinogen is unknown, cysteine and ascorbic acid being the only simple substances tested which show similar reducing power, but the negative nitroprusside test suggests that the former is not responsible. It is known that tyrosine and tryptophane reduce iodine in phosphate buffer, and the reducing action may be in some part due to this. Fibrinogen, however, contains a group with much stronger reducing properties than either tyrosine or tryptophane, and the number of such groups apparently increases on conversion of the fibrinogen to fibrin.

Greenland Plants

THE Julianehaab district of south-west Greenland is climatically the most favoured area of that country. It has been many times visited by botanists, and its flora, comprising about 300 indigenous vascular plants, was regarded as one of the best known throughout Greenland. Two months intensive botanizing during the summer of 1937, however, enabled N. Polunin (*J. Linn. Soc.*, **52**, No. 345; Oct. 1943) to add another twenty-one species—exclusive of introduced plants—to the flora of this district. Eleven of these are new to Greenland, the rest being species not previously known to occur so far south. The new discoveries include *Botrychium tenebrosum* Eaton, *Danthonia spicata* (L.) Beauv., *Carex Mackenziei* Krecz., *C. magellanica* Lam., *Gentiana Amarella* L. (Agg.) and *Antennaria compacta* Malte. *Potamogeton natans* L. is also new to Greenland, but the endemic *P. groenlandicus* of Hagström is reduced to *P. Berchtoldii* Fieb. The plant which had previously been recorded from this district as *Equisetum hiemale* L. is now identified as *E. trachyodon* A. Br. In view of the suggestions which have been put forward that the latter is the hybrid *E. hiemale* × *variegatum*, its occurrence in a country from which *E. hiemale* appears to be absent is of considerable interest. This contribution to the flora and phytogeography of south-western Greenland consists of an enumeration of all vascular plants known to grow in the area visited, with critical notes thereon. Students of the British flora will find much of interest and value in the treatment of polymorphic species such as the alpine Cerastia, *Plantago maritima*, *Juncus alpinus*, Poa spp., Carex spp., and others. *Matricaria suaveolens* is one of the score of alien plants added to the already considerable list of introduced species.

Multiperforate Plates in Xylem Vessels of Monocotyledon Roots

VON MOHL described net-like cross walls in the vessels of palm roots, and B. C. Kundu (*Proc. Ind. Acad. Sci.*, **16**, 6; 1942) has now shown that the multiperforate is the only type of vessel segment to occur in the roots of certain Araceæ (Colacasia and Alocasia) and also in Crinum, and they are also of frequent occurrence in *Canna indica*. These roots do not have secondary thickening, so that the scalariform-reticulate vessels in which the multiperforate plates occur are in the protoxylem formed about the time of cessation of growth in length. The occurrence of this type of vessel segment associated with earlier differentiated tracheid-like spiral protoxylem elements is of interest, but does not appear to be the same phenomenon as the less general occurrence of multiperforate plates in vessels of certain relatively specialized, herbaceous dicotyledon shoots such as *Helianthus annuus* and *Heracleum Sphondylium*. They are also so different from the scalariform perforations of certain woody dicotyledons, that it would seem premature to draw conclusions as to the primitive nature of the vessels in these monocotyledonous roots.

Fusarium Wilt of the Carnation

THE fungus *Fusarium Dianthi* causes a serious wilt disease of the carnation crop on Long Island, U.S.A. This malady has been studied by J. M. Bickerton (Bull. 788, Cornell Univ. Agr. Exp. Sta., Ithaca, N.Y., December 1942). Yellowing, stunting and necrosis accompany the wilted condition, and the pathogen is soil-borne. It generally enters the host through the roots and progresses very rapidly into the shoots when temperatures are optimal—about 80° F. Control measures suggested include the selection of healthy cuttings and the use of resistant varieties grown upon fresh soil. Soil disinfection is apparently successful only within the limits of greenhouse benches, and not in the open. It is interesting that, in addition to formaldehyde, the incipient war 'gas' chloropicrin has been found satisfactory for this purpose—a subtle variant of the beating of swords into ploughshares.

Structure of Boron Hydrides

THE structure of the hydrides of boron has been the object of many theoretical investigations and is still somewhat puzzling. H. C. Longuet-Higgins and R. P. Bell (*J. Chem. Soc.*, 250; 1943) have adopted the view that the molecules contain a hydrogen bridge linkage $>B\!:\!\genfrac{}{}{0pt}{}{\cdot H \cdot}{\cdot H \cdot}\!:\!B<$ which is regarded as a resonance hybrid between structures containing only normal electron-pair bonds, and differs from the ordinary type of hydrogen bond. This provides an explanation of the diamagnetic character of B_2H_6 and agrees with the fact that all the boron hydrides contain an even number of electrons. The absence of a direct link between the boron atoms explains the chemical behaviour of the hydrides. The authors discuss the bearing on the hypothesis of the data for the electron diffraction, Raman spectrum, infra-red spectrum and specific heat of B_2H_6, which support a bridge configuration rather than one resembling ethane. Structures for the higher hydrides are suggested.

Synthesis of Adenine

IN the synthesis of adenine by Traube in 1904 from 4 : 5 : 6-triamino-2-thiolpyrimidine the overall yield was poor. J. Baddiley, B. Lythgoe and A. R. Todd (*J. Chem. Soc.*, 386; 1943) describe a synthesis from 4 : 5 : 6-triaminopyrimidine as parent substance, this being obtained by reduction of 4 : 6-diamino-5-benzeneazopyrimidine, formed by the condensation of formamidine with benzeneazomalononitrile. The thioformyl derivative of 4 : 5 : 6-triaminopyrimidine was converted on boiling in aqueous or pyridine solution into adenine, with high overall yield (more than 50 per cent). A comparison of the ultra-violet absorption spectrum of the synthetic product with that of natural adenine showed no divergence. This work makes adenine a readily accessible compound, and similar methods of synthesis could probably be applied in the case of other naturally occurring purines. In another paper, by G. W. Kenner, B. Lythgoe, A. R. Todd and A. Topham (*J. Chem. Soc.*, 388; 1943) some reactions of amidines with derivatives of malonic acid are described, in which some results of other earlier experimenters are corrected.

Constitution of the Solar Corona

A NEW theory of the solar corona has been put forward by H. Alfvén in a paper which has recently reached Great Britain (*Ark. Mat. Astron. Fys.*, 27A, No. 25; 1941). Observational facts have been accumulating for many years that particles exist at or near the sun's surface with energies of perhaps hundreds of electron volts, at any rate far above that corresponding to the photospheric temperature. The hypothesis suggested is that the corona is an atmosphere consisting entirely of such particles. If the light of the corona is regarded as sunlight scattered by electrons which are in equilibrium under gravitation and thermal agitation alone, the observed density function leads to an energy distribution in which the mean energy of the electrons remains almost constant at 180 eV. in the region between 0·2 and 2 solar radii from the surface. This corresponds to a thermal equilibrium temperature of nearly 1·4 million degrees. A very good representation of this state of affairs is found if about 10^{-5} of the solar energy output is used in producing high-energy particles in the upper chromosphere, and if the low density of the corona prevents loss by radiation. A still better agreement with observation is obtained by allowing for the force on the charged particles due to the gradient of the general magnetic field of the sun; in this case the temperature found is about half that for the simpler assumption. The theory explains at least qualitatively the production of the emission lines and their great breadth, and the characteristic ray structure observed near the magnetic poles of the sun.

Stellar Companions of Small Mass

IN an article (*Pub. Astro. Soc. Pacific*, **55**, 79; 1943) H. N. Russell investigates the probable physical characteristics of the quasi-planets recently found in the systems 61 Cygni and 70 Ophiuchi (NATURE, **152**, 66; 1943). The gravitational attraction of these bodies causes perturbations in the motions of their primaries which suggest that they are only about one-hundredth the mass of the sun. On various plausible assumptions as to the chemical composition of such companions, Russell deduces upper and lower limits for their radii and for their internal and surface temperatures. Even at their hottest the companions are probably not self-luminous, though their internal constitution resembles that of a star. Almost certainly most of their light will be that reflected from the primaries. Until about thirty years ago it was believed that Jupiter and Saturn were feebly self-luminous, yet no objections were raised to calling them planets. Probably the newly discovered bodies are much bigger relative to their primaries than the solar planets, but that raises no insuperable objection in nomenclature; before the secondary minimum of Algol was discovered its variation was described as due to eclipses "by an enormous planet". The author concludes that it is well within the bounds of accepted usage to describe the new bodies as planets.

Polyatomic Emission in the Visual Spectra of Comets

CLOSE on the heels of the discovery a year ago that the bands near 4050 A. in cometary spectra are due to the polyatomic emitter CH_2 comes the news that the strong 6300 A. group is probably to be attributed to NH_2. Study of cometary spectra in the visual region has not progressed as fast in the past few decades as the improvement in photographic plates might suggest, mainly because of the lack of fast grating spectrographs and of bright comets. The present work (*Astrophys. J.*, 98, 142; 1943) is the result of co-operative study of the spectra of Comet Cunningham and Comet Whipple II carried out at the McDonald, Dominion Astrophysical and Mt. Wilson Observatories. Wave-lengths are given for the emission features in the spectra of the heads of these comets in the region 4800–7050 A., and possible identifications are discussed. The group of bands at 6300 A., which is the strongest unidentified feature, behaves with respect to heliocentric distance much as the 4050 A. group does. Many coincidences are noted with bands in the spectrum of the ammonia-oxygen flame, and it is suggested that the emitter is a photo-dissociation product of ammonia liberated from the solid constituents of the cometary nucleus. Study of the electronic structure and the energy-level diagram to be expected in NH_2 suggests that this molecule is likely to be the one responsible, particularly as the NH molecule, a product of further dissociation, is known to be well represented in cometary spectra.

THE VETERINARIAN AND THE COLONIES

MAJOR J. M. SMITH, who was formerly chief veterinary officer to the Department of Agriculture and Fisheries, Government of Palestine, recently gave to the National Veterinary Medical Association of Great Britain and Ireland a valuable address on the part played by the veterinarian in the development of our Colonies (*Vet. Rec.*, **55**, 415; 1943).

Colonial development requires, he said, many specialists. The population of the Colonies are usually natives with a pastoral economy, which is sometimes nomadic. Cattle are the wealth of the community, and tribal influence often depends on the number of cattle possessed by the tribe. Improvement of the existing agricultural methods results in more settled communities, better trade and food production and increase in the population, with higher standards of health among the people and their domestic stock. Development of trade requires development of trade routes and of means of transport, and these require further measures of health control. It is clear that the veterinary surgeon taking part in developments of this kind has to adapt himself to conditions very different from those prevailing in the British Isles.

Like the missionary, administrator and the medical man, he must try to understand the people and their customs; he must also study the climate and the wild and domestic animal life. Major Smith says that, after some years of work of this kind, the chief contagious diseases of cattle are being gradually controlled in our Colonies; from some of them they have been eradicated. Parts of Africa, however, still await general development. Not all Colonies give the veterinary officer his due; not all of them realize how useful he can be. Major Smith tells us exactly how he can help the administrator.

His first function must be active work in the field and research in the laboratory on rapidly spreading contagious diseases such as rinderpest, trypanosomiasis, tuberculosis, anthrax and swine fever. The amount of work involved is indicated by the fact that in Nigeria in 1941 433,000 cattle were vaccinated and 182,000 temporarily immunized against rinderpest, while 300,000 were vaccinated against blackquarter and 500,000 against hæmorrhagic septicæmia. By selective breeding, elimination of inbreeding and castration of inferior stock the general level of livestock is being improved. Artificial insemination is being used on a small scale in Kenya and Palestine with encouraging results. Improvement of stock creates demands for movement of stock over great distances, and trade routes for these movements have to be guarded against disease by inspection, regulations and research. When trade in hides, skins, ghee, butter and similar products develops, the veterinary officer must help the native to improve the production of these. In Uganda, for example, the value of exported hides and skins in 1939 was about £90,000; in 1941 it was £140,000. Similar increases have occurred in Kenya and Nigeria. In some Colonies dairying has become a valuable industry. Kenya, for example, produced, in 1940, 3½ million pounds of butter and 300,000 pounds of cheese. The commercialization of the native ghee, made by extracting the fat from milk, has resulted in a large export trade in this for Kenya, Nyasaland and Tanganyika Territory. Other Colonies await similar development.

The export of cattle and meat from Colonies where east coast fever and contagious bovine pleuropneumonia flourish is difficult or impossible; other countries will not import such stock. Some Colonies afflicted with such diseases have, therefore, fallen back on the production or export of canned and frozen meat produced in their own plants. Efficient meat inspection by veterinary officers is demanded by the importing countries and is, indeed, essential to the production of meat for human consumption. To help in this work selected natives are being educated in Kenya and Nigeria in the use of simple veterinary equipment and in the administration of drugs by the mouth and of sera and vaccines and in animal husbandry.

In most of our Colonies, veterinary departments have now been established and these are in no way subordinate either to the agricultural or the medical departments; the pay and conditions of service of their personnel compare favourably with those of the medical, legal, engineering and other professional services. This is as it should be everywhere. Major Smith thinks, however, that the great work being done by the colonial veterinary officer will be greater still in the future. He concludes his address with his views upon these future developments. Among future colonial problems he mentions the tackling of diseases of farm stock which are still causing enormous financial losses at home, and the prevention of the entry of these into our Colonies, improvements in the housing and feeding of animals and in the killing centres and meat production plants, the organization and establishment of dairies and the maintenance of the health of the increased animal populations. The broadening of veterinary education, the co-operation of the universities and the aid of the Government will all be required if we are to educate rightly the right sort of men for this important colonial work.

Contributors to the interesting discussion which followed the address showed substantial agreement and some amplification of it. Among the speakers were Mr. John Smith, adviser in animal health to the Colonial Office; Sir Arthur Olver, principal of the Royal (Dick) Veterinary College; Prof. Kearney of Dublin, and other veterinarians who have had long experience of veterinary administration and practice in Egypt, the Sudan, India, Kenya, Nigeria, West Africa and South Africa. We cannot summarize their remarks here, but it is pertinent to mention Sir Arthur Olver's reference to the work of Sir Arnold Theiler in South Africa and of Dr. Moehler in the United States. The work of both these men, said Sir Arthur, has revolutionized the agricultural industries of both these countries, with enormous economic and social benefit to them. Prof. Kearney, in the course of a speech which illustrated the brilliant successes of the veterinary profession in a comparatively short time, quoted Dr. Julian Huxley's "Africa View". "In Africa," wrote Huxley, "the prosperity and, indeed, the habitability of enormous areas hangs upon his (the veterinarian's) success or failure in research along the broadest biological and medical lines. . . . To be a good veterinary officer in Africa you must be a first-class biologist and you must be a knowledgeable and sympathetic anthropologist as well." These words might well form part of the terms of reference for any committee which is asked to report upon veterinary education in Great Britain or in any other country (see p. 35 of this issue).

ARCHÆOLOGICAL RECONNAISSANCE IN GUATEMALA

THE memoir on "Archæological Reconnaissance in Campeche, Quintana Roo, and Peten", as its name implies*, describes a reconnaissance, comprising four expeditions organized by the Carnegie Institution between 1932 and 1938, which did not include any excavation. The region is densely forested and practically uninhabited, but with the aid of the local knowledge of the chicle collectors the expeditions proved it to be rich in Maya remains. These present many interesting features, which are set out in a short summary. This is followed by a description of individual sites, the geographical position of which is given in each case to the nearest 0·1 minute of arc, a wise precaution in an area where clearings vanish in a few seasons. A section on the monuments, with a useful chronological table, follows. In the introduction to this is described a method of taking rubbings, which may well prove useful to workers elsewhere for the recording of carvings in low relief, provided that the proper type of long-fibred Korean paper can still be obtained. The illustrations, comprising a liberal allowance of plans, sections and photographs, are grouped at the end.

The buildings in the southern area, associated with the Peten, differ in style from those in the north. The southern group has undecorated lower zones, an indentation in each side wall and a slight projection of the central part of the back wall. The northern, or Rio Bec type, has in its most striking instances two or three ornamental masonry towers which rise above the roof, but even where these are absent, it is distinguished by elaborately decorated façades. A restoration drawing of a notable example with three towers at Xpuhil forms the frontispiece of the work. The southern group is dated by means of the stelæ between 8.18.9.17.18 and 10.3.0.0.0, or between the first and seventh centuries A.D. according to Spinden's correlation, but no decipherable dates have yet been found in the northern group, though there is some evidence that they were contemporary.

Parallels to Group E, at Uaxactun, believed to have been a solar observatory, were found in a number of sites in the centre and south of the area. The axial line departs by varying amounts up to 15° from true east, without any apparent correlation with latitude, so it is suggested that the origin of the grouping may be astronomical, but the later examples merely ritualistic.

A particularly interesting vaulted building, unfortunately far from perfect, in which the true arch was almost attained, was found at La Muñeca. Another site, Pechal, seems to have included an amphitheatre. Like the majority of Maya sites, most of those visited were without defences, but one town, Becan, had an elaborate moat, traversed by seven causeways, though it is uncertain whether this was ever completed.

Considering the overgrown nature of the country and the bad state of the monuments, these four short expeditions brought back a great wealth of material, which is admirably presented. Excavation will doubtless follow as soon as it is practicable.

G. H. S. BUSHNELL.

* Archæological Reconnaissance in Campeche, Quintana Roo, and Peten. By Karl Ruppert and John H. Denison, Jr. (Publication 543.) Pp. vii+230+75 plates. (Washington, D.C.: Carnegie Institution.) 4.25 dollars.

GENEALOGY OF HUMAN FOLLY

SCHOLARS are to-day busy tracing the spiritual antecedents, before Pan-Germanism, of Herr Hitler. Substantial work has shown the linear connexion with Luther. Prof. Collingwood even triumphantly exposed the scalp of an ancestor in the person of Thomas à Kempis. A study of the similarity of Hitler and Mr. G. B. Shaw has yet to be made. The similarity with Carlyle (and dissimilarity with Emerson) is substantial and extensive in the vertical line, when all allowance is made for the fact that Hitler, Carlyle and Emerson are all horizontally men of their time and place.

Prof. MacKeehan, in the most recent issue of the University of Colorado Studies (vol. 2), has made a useful contribution by underlining this. There is a genealogy of human folly as well as of truth. It is well to be reminded that Thomas Carlyle wrote: "Germany, from of old, has been the peaceablest, most pious, and in the end most valiant and terriblest of nations. Germany ought to be President of Europe, and will again, it seems, be tried with that office for another five centuries or so". This indicates the danger of judging any people's policy by the ideas of its literary nabobs. In fairness, however, to Carlyle and Emerson, it should be said that they were more concerned with what is now fashionably called 'the restoration of moral values' than with the nature of leadership.

Prof. MacKeehan's study will have done good work if it deters a few would-be leaders from supplying us with moral reach-me-downs from their nearest peg as poor Carlyle tried to do from the Ecclefechan store. The University of Colorado, always known as a foyer of ideas, is to be congratulated on its enterprise, although I found the "Thirteen Points of Spelling and Punctuation" enjoined on contributors intimidating. I am against standardization alike in printing and politics; and rejoiced when the revolting printer's devil produced the magnificent variant 'virute'.

GEORGE CATLIN.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, January 8

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. C. E. N. Bromehead: "Geology and Health".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "Vibrations and Waves", 6: "Long Electromagnetic Waves".*

Monday, January 10

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Capt. the Rev. H. R. Rokeby-Thomas: "Islands of the Canadian Arctic".

Tuesday, January 11

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP) (joint meeting with the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. A. J. Andersen: "The Manufacture of Margarine".

IRON AND STEEL INSTITUTE (joint meeting with the STAFFORDSHIRE IRON AND STEEL INSTITUTE) (at the Dudley and Staffordshire Technical College, The Broadway, Dudley), at 7 p.m.—Mr. J. H. Whiteley: "A Study of Austenitic Grain Growth in Medium-Carbon Steels".

Wednesday, January 12

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (joint meeting with the FARADAY SOCIETY to which the LONDON SECTION OF THE OIL AND COLOUR CHEMISTS ASSOCIATION is invited) (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2 p.m.—Symposium on "Molecular Weight and Molecular Weight Distribution of High Polymers" (to be opened by Prof. H. W. Melville, F.R.S.).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Sir Frank Smith, G.C.B., F.R.S.: "The Story of Petroleum—A Giant of Modern Industry".

Thursday, January 13

CHEMICAL SOCIETY (joint meeting with the SOCIETY OF CHEMICAL INDUSTRY, the ROYAL INSTITUTE OF CHEMISTRY, and the BRITISH ASSOCIATION OF CHEMISTS) (in the Muspratt Lecture Theatre, The University, Liverpool), at 4 p.m.—Prof. E. D. Hughes: "The Reactivity of Organic Compounds".

INSTITUTE OF FUEL (joint meeting with the BRISTOL AND SOUTH-WEST COUNTIES SECTIONS OF THE SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL SOCIETY, and the ROYAL INSTITUTE OF CHEMISTRY) (in the Chemistry Department, The University, Woodland Road, Bristol), at 5.30 p.m.—Mr. G. M. Gill and Mr. John Roberts: "Post-War Coal Processing".

IRON AND STEEL INSTITUTE (joint meeting with the EBBW VALE METALLURGICAL SOCIETY) (at the Rational Hall, Ebbw Vale), at 7 p.m.—Dr. C. H. Desch, F.R.S.: "Research in the Steel Industry".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Presentation of the Hanbury Memorial Medal to Sir Henry Dale, F.R.S., followed by an address on "The Natural History and Chemistry of Drugs".

Friday, January 14

INSTITUTE OF FUEL (at the Chamber of Commerce, Swansea), at 4 p.m.—Mr. H. R. Horman: "The Production of Producer-Gas and Blue Water Gas".

Saturday, January 15

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 2.30 p.m.—Annual General Meeting. Presidential Address.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SCIENCE MASTER, mainly for CHEMISTRY, up to University Scholarship standard, at the City of London School—The Town Clerk, 55–61 Moorgate, London, E.C.2 (January 12).

CHAIR OF CHEMISTRY—The Principal, University College of Wales, Aberystwyth (January 15).

REGIUS PROFESSOR OF ZOOLOGY at Glasgow University—The Private Secretary, Scottish Office, Fielden House, 10 Great College Street, London, S.W.1 (January 17).

HEAD OF THE DEPARTMENT OF ENGINEERING, Schools of Technology, Art and Commerce, Oxford—The Chief Education Officer, City Education Office, 77 George Street, Oxford (January 19).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

ASSISTANT LECTURER IN CHEMISTRY, PHYSICS AND BOTANY—The Principal, Swanley Horticultural College for Women, Swanley, Kent.

LECTURER IN THE ENGINEERING DEPARTMENT—The Registrar, Technical College, Cheltenham, Glos.

SCIENCE MASTER or MISTRESS to be responsible for the teaching of CHEMISTRY to Higher School Certificate standard—The Headmaster, Wellingborough Grammar School, Wellingborough, Northants.

EXECUTIVE ENGINEERS for the Sierra Leone Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.774A).

REPORTS and other PUBLICATIONS

Great Britain and Ireland

An Open Letter to Lords, Commons and Press. By Lionel Curtis. Pp. 12. (Oxford: The Author, All Souls College.) [3011

Abolition of Tuition Fees in Grant-Aided Secondary Schools. Pp. 16. (London: National Union of Teachers.) [3011

British Coal Utilisation Research Association. The First Five Years: Report for the Period 1938–1942. Pp. 28. (London: British Coal Utilisation Research Association.) [3011

Memorandum on Official Statistics. Pp. 22. (London: Royal Statistical Society.) [3011

The Equilibrium Diagram of the System Aluminium—Zinc. By Dr. G. V. Raynor. (Annotated Equilibrium Diagram Series, No. 1.) Pp. 4. (London: Institute of Metals.) 6*d*. [3011

University of Cambridge: Solar Physics Observatory. Report for the Year 1942 October 1 to 1943 September 30. Pp. 2. (Cambridge: Solar Physics Observatory.) [3011

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences.) Vol. 62, Part 1, No. 2: The Fundamental Concepts of Natural Philosophy. By Prof. E. A. Milne. Pp. 10–24. 1*s*. 3*d*. Vol. 62, Part 1, No. 3: On the Matrix Representation of Complex Symbols. By Dr. D. E. Rutherford. Pp. 25–27. 6*d*. Vol. 62, Part 1, No. 4: A Note on Karl Pearson's Selection Formulæ. By D. N. Lawley. Pp. 28–30. 6*d*. Section B (Biology). Vol. 62, Part 1, No. 4: Meiosis in the Striped Hamster (*Cricetulus griseus* Milne-Edw.) and the Problem of Heterochromatin in Mammalian Sex-Chromosomes. By Dr. G. Pontecorvo. Pp. 32–42. 1*s*. (Edinburgh and London: Oliver and Boyd.) [3011

Ventilation and Heating, Lighting and Seeing. (Conditions for Industrial Health and Efficiency, Pamphlet No. 1, issued by the Industrial Health Research Board of the Medical Research Council.) Pp. 20. (London: H.M. Stationery Office.) 3*d*. net. [112

Ministry of Health: Second Report of Nurses Salaries Committee. Salaries and Emoluments of Male Nurses, Public Health Nurses, District Nurses and State Registered Nurses in Nurseries. (Cmd. 6487.) Pp. 52. (London: H.M. Stationery Office.) 9*d*. net. [312

City and Guilds of London Institute. Higher Technical Education. Pp. 12. (London: City and Guilds of London Institute.) [312

Evolutionists under Fire. By Lieut.-Colonel L. M. Davies and Douglas Dewar. Pp. 20. (Edinburgh: Lieut.-Colonel L. M. Davies, 8 Garscube Terrace.) 3*d*. [612

Communications of the Dublin Institute for Advanced Studies. Series A, No. 1: Quantum Electrodynamics. By Paul A. M. Dirac. Pp. 36. 2*s*. Series A, No. 2: The Combination of Relativity Theory and Quantum Theory. By Sir Arthur S. Eddington. Pp. 69. 3*s*. (Dublin: Dublin Institute for Advanced Studies.) [812

Board of Education. Education Bill: Explanatory Memorandum by the President of the Board of Education. (Cmd. 6492.) Pp. 14. (London: H.M. Stationery Office.) 3*d*. net. [1712

British Empire Cancer Campaign. Twentieth Annual Report, 1943. Edited by J. P. Lockhart-Mummery. Pp. 92. (London: British Empire Cancer Campaign.) [1712

Training for Industrial Management. A Report of a Conference held in London, March 5th–7th, 1943. Pp. 96. (London: Institute of Industrial Administration.) 2*s*. 6*d*. [1712

Other Countries

Bulletin of the Madras Government Museum. New Series, Natural History Section, Vol. 1, No. 2, Part 5: The Foraminifera of Krusadai Island (in the Gulf of Manaar). By Dr. C. P. Gnanamuthu. Pp. 21+4 plates. (Madras: Government Press.) 1.6 rupees. [1211

Forest Research in India and Burma, 1941–1942. Part 1: The Forest Research Institute. Pp. iv+151. (Dehra Dun: Forest Research Institute.) 1.4 rupees; 1*s*. 11*d*. [1511

Bulletin of the Zoological Society of San Diego. No. 18: i. Tail-Length Differences in Snakes, with Notes on Sexual Dimorphism and the Coefficient of Divergence; ii. A Graphic Method of Showing Relationships. By L. M. Klauber. Pp. 76. (San Diego, Calif.: Zoological Society of San Diego.) [1811

Smithsonian Institution. War Background Studies, No. 16: Island Peoples of the Western Pacific—Micronesia and Melanesia. By Herbert W. Krieger. (Publication 3737.) Pp. iv+104+21 plates. (Washington, D.C.: Smithsonian Institution.) [2311

Decentralisation of University Education. By Dr. Edgar Booth. Pp. 16. (Armidale, N.S.W.: New England University College.) [2411

University of Pennsylvania. The Electrical Conductivity of Lead Chromate: a Dissertation in Physics presented to the Faculty of the Graduate School in partial fulfilment of the requirements for the Degree of Doctor of Philosophy. By Theodore William Lashoff. Pp. 10. (Philadelphia: University of Pennsylvania.) [2611

Bernice P. Bishop Museum. Special Publication 36: South Sea Lore. By Kenneth P. Emory. Pp. 75. (Honolulu: Bernice P. Bishop Museum.) [2611

Dominion Observatory. Report for the Year ended 31st December, 1942. (Dominion Observatory Bulletin No. R.28.) Pp. 2. (Wellington: Government Printer.) [3011

Classified List of Smithsonian Publications available for Distribution, October 1, 1943. Compiled by Helen Munroe. (Publication 3736.) Pp. iv+48. (Washington, D.C.: Smithsonian Institution.) [3011

Annals of the New York Academy of Sciences. Vol. 44, Art. 3: Parasitic Diseases and American Participation in the War. By Horace W. Stunkard, Lowell T. Coggleshall, Thomas T. Mackie, Robert Matheson and Norman R. Stoll. Pp. 189–262. (New York: New York Academy of Sciences.) [312

Department of Public Instruction, Technical Education Branch, New South Wales. Technological Museum: Curator's Annual Report for the Year ended 31st December 1942. Pp. 6. (Sydney: Technological Museum.) [312

Nyasaland Protectorate. Annual Report of the Forestry Department for the Year ended 31st December 1942. Pp. 16. (Zomba: Government Printer.) 1*s*. [712

The Mosquito. (Educational Wallsheet No. 2.) 22½ in. × 17½ in. (Cape Town: The African Bookman.) [712

Stanford University Publications: University Series. Biological Sciences, Vol. 9, No. 1: Biology, Ecology and Morphogenesis of a Pelagic Foraminifer. By Earl H. Myers. Pp. 30+4 plates. 4*s*. 6*d*. net. Geological Series, Vol. 3, No. 3: Eocene Foraminifera from the Type Lodo Formation, Fresno County, California. By Lois T. Martin. Pp. 91–126+plates 5–9. 4*s*. 6*d*. net. (Stanford University, Calif.: Stanford University Press; London: Oxford University Press.) [912

Bulletin of the National Research Council. No. 107: Data on Chemicals for Ceramic Use; Formulas, Molecular Weights, Colors, Crystal Forms, Densities, Refractive Indices, Melting Points, Boiling Points, Transition Points, Decomposition Temperatures. Pp. 94. (Washington, D.C.: National Research Council.) 2.50 dollars. [1012

Newfoundland: Department of Natural Resources. Game Laws. Pp. 66. (St. John's: Department of Natural Resources.) [1012

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 162: The Soil and Land-Use Survey of the Wakool Irrigation District, New South Wales. By R. Smith, R. I. Herriot and E. J. Johnston. Pp. 60. (Melbourne: Government Printer.) [1712

The Commonwealth Fund. Publications, 1943. Pp. 32. (New York: The Commonwealth Fund.) [1712

Bulletin of the American Museum of Natural History. Vol. 81, Art. 5: Bees of the Genus *Colletes* chiefly from Colorado. By P. H. Timberlake. Pp. 385–410. (New York: American Museum of Natural History.) [1712

Science and the War. A Symposium presented at the seventy-fifth Anniversary Meeting of the Kansas Academy of Science, Lawrence, Kansas, April 10, 1943. Pp. 48. (Lawrence, Kansas: Kansas Academy of Science.) [1712

U.S. Department of Agriculture. Farmers' Bulletin No. 1928: Mormon Crickets and their Control. By F. T. Cowan, H. J. Shipman and Claude Wakeland. Pp. ii+18. 10 cents. Technical Bulletin No. 853: Studies of Methyl Bromide in Greenhouse and Vault Fumigation. By Henry H. Richardson, A. C. Johnson, J. W. Bulger, A. H. Casanges and G. V. Johnson. Pp. 20. 5 cents. Technical Bulletin No. 855: The Beet Leafhopper and its Control on Beets Grown for Seed in Arizona and New Mexico. By Van E. Romney. Pp. 24. (Washington, D.C.: Government Printing Office.) [1712

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SCIENCE IN THE NEW WORLD ORDER

THE special meeting of the Royal Society held in India on January 3 was the occasion of a message from the Prime Minister to scientific workers which should be given wide publicity. It will be remembered that, at the anniversary meeting of the Royal Society on November 30, Sir Henry Dale referred in the course of his presidential address to the visit to India of Prof. A. V. Hill, and to a proposed special meeting of the Society to be held in that country at which Prof. Hill would be able formally to admit to the Society those Indian fellows who had not hitherto been able to sign the Charter Book. The meeting took place on January 3. On that day, in the hall of St. Stephen's College, Delhi, the Indian Science Congress Association opened its annual meeting. The inaugural ceremony was preceded by a short address by Prof. Hill, who declared the great gathering to be a meeting of the Royal Society. Dr. H. J. Bhabha and Sir Shanti Bhatnagar were duly admitted and subscribed to the fellow's obligation on a sheet of parchment to be included later in the Charter Book.

With that simple ceremony, this short special meeting of the Royal Society was brought to a close; but it is safe to predict that it will long be remembered in scientific circles in India and elsewhere. H.M. the King, as Patron of the Society, was represented by His Excellency the Viceroy, who afterwards delivered an address. Prof. Hill himself reminded his audience that this was the first occasion on which the Royal Society had held a meeting outside England, and that its purpose was to convey the greetings and goodwill of the Society to the scientific workers of India. He quoted from a letter by Sir Henry Dale to the president of the Indian Science Congress Association suggesting this special meeting, in which Sir Henry said: "There is a general desire among the men of science in Britain for a more intimate collaboration with those in India who are working for the advancement of knowledge in the same fields of research", and concluding by expressing the hope that Prof. Hill's visit "will strengthen the bonds of understanding and true comradeship between Indian and British men of science".

The same notes of greeting and comradeship sounded in messages sent to Prof. Hill on the eve of his departure for India. Sir Richard Gregory, president of the British Association, the sister body of the Indian Science Congress Association, said that the "place of a country among the nations of the world to-day depends on the extent to which use is made of its resources in men and material. . . . The mission of science is the discovery of truth, to whatever consequences it may lead. The urgent duty of scientists to-day is to ensure that the message is interpreted rightly for the good of mankind." General Smuts also referred to the paramount importance of scientific research in relation to industry, agriculture, war and in other directions; and he continued, "In the great forward movement of India in our day, which is so universally acclaimed, there

is nothing more outstanding than the part her sons are taking in science and scientific research, and some of the most notable advances in physics, mathematics and the biological sciences have come from Indian workers."

Finally, Prof. Hill read the following message from the Prime Minister:

"I am very glad to have the opportunity to send through you my greetings and good wishes to Indian men of science and especially to the six Indian Fellows of the Royal Society, of which I am honoured to be myself a Fellow. It is the great tragedy of our time that the fruits of science should by a monstrous perversion have been turned on so vast a scale to evil ends. But that is no fault of science. Science has given to this generation the means of unlimited disaster or of unlimited progress. When this war is won we shall have averted disaster. There will remain the greater task of directing knowledge lastingly towards the purposes of peace and human good. In this task the scientists of the world, united by the bond of a single purpose which overrides all bounds of race and language, can play a leading and inspiring part."

There should be cause for deep satisfaction to scientific workers in these words from Mr. Churchill, because they carry a significance far beyond the occasion for which they were written. It is a truism to state that the fruits of science have been misused, and that on a vast scale. They have been misused in the past; each new discovery seems to have been matched with an evil mind ready to turn it to personal advantage at the cost of human suffering, until with the present War we have reached a climax. But, the Prime Minister goes on, "that is no fault of science". These words should be proclaimed throughout the world. Year in and year out, scientific men have been at pains to show by the written word and otherwise that scientific research is the search for truth and for the understanding of the workings of Nature, and in these columns we have continually striven to drive home their arguments. So far as men of science were concerned, we were in large measure 'preaching to the converted'; but the continued lack of appreciation of the position among those who had not had training in scientific methods justified the effort.

With the increasing utilization—intrusion some have called it—of cience in industry, transport, agriculture and practically every other phase of human activity witnessed during the twentieth century, there has been a growing tendency to put the blame for every man-made disaster, from wars downwards, on science. Both the War of 1914–18 and the present War have been notorious for the use that has been made of science for destructive purposes.

In consequence, there is still a widespread feeling among laymen that science is always and everywhere an agent of destruction, and its great gifts to mankind are overlooked or forgotten. If anyone doubts this, let him study the correspondence printed in the daily Press, or take the views of the generation now serving in the Armed Forces, on whom the building of the new world order will depend. When confronted with a modern development such as the aeroplane, it is perhaps not to be wondered at that the superficial observer may think only of the destruction that has been wrought by man's misuse of this wonderful means of transport, by means of which even the natural barriers imposed by the physical features of the earth's surface can be surmounted quickly and comfortably. The spate of propaganda that has been spilled over the world since radio-telephony became possible has made it easy to forget that broadcasting could be used equally well to bring the nations together through the exchange of cultural knowledge. 'War gases' is a common phrase, on which the comment, so well known to scientific men, that not one of the gases used or suggested for this purpose was discovered in the course of investigations directed to this end, cannot be too often repeated. Under the stress of war, little thought is given to the relief of suffering brought about by the discovery of insulin, the sulpha drugs and now penicillin, except in relation to war injuries.

The examples could be multiplied almost indefinitely, as every scientific worker knows; what he does not realize clearly enough is that the general public still requires instruction. In spite of the growth of science teaching in schools, the young people of to-day, unless they happen to be interested professionally in science, seem incapable of seeing the scientific facts they acquired at school as parts of the larger problems of modern life; their education is clearly incomplete. Here scientific workers can play a useful part; for although we cannot at present prevent man from utilizing science for destructive purposes, we can at least attempt to make him see the folly of ignoring the gifts that science offers as contributions to his happiness and welfare. Every man of science should regard himself as a prophet of the scientific era, working actively for a better understanding of the meaning of science and scientific discovery among his fellow-men.

But the Prime Minister did not stop at the exoneration of science from the blame for wars. He pointed to the future, and to "the greater task of directing knowledge lastingly towards the purposes of peace and human good". In the new world order towards which the United Nations are striving, science will be of increasing importance. To fulfil the letter and the spirit of the Atlantic Charter, great stores of knowledge about the resources of the world must be gathered in, classified and utilized with due regard to the many human factors involved. In doing this, every conceivable branch of science will be involved, and men of science of all nations, acknowledging in their work only an allegiance to the search for truth, can, in the words of the Prime Minister, "play a leading and inspiring part" in the building up of a stable civilization.

Mr. Churchill's brief message will inspire scientific men to attack the innumerable problems awaiting them during the War and afterwards with redoubled vigour and a new confidence that their work will not be in vain.

LIFE AND MENTALITY OF THE CHIMPANZEE

Chimpanzees

A Laboratory Colony. By Prof. Robert M. Yerkes. Pp. xv+321+63 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1943.) 33*s*. 6*d*. net.

CHIMPANZEES are scarcely common experimental animals. In so far as they have been investigated under laboratory conditions at all, the credit is very largely due to Prof. R. M. Yerkes, until lately in charge of the Yale Laboratories of Primate Biology. It was Prof. Yerkes's insistent belief in the necessity for studying these near-human animals, and his patience in stating the case, that finally resulted in the munificent endowment by the Rockefeller Foundation of laboratories in New Haven, Connecticut, and of an anthropoid experimental station in Florida. As fast as the material facilities grew, research students were attracted. Their work over the fifteen years or so that the laboratories have been in operation forms the subject-matter of a large number of papers dealing with anthropoid psychology and physiology. Yale proved very fruitful soil for such investigations. Side by side with Prof. Yerkes's department there grew up, under Prof. J. F. Fulton, another department which is mainly concerned with the study of primate physiology, and in particular with the study of neurological mechanisms in apes and monkeys. A little later Prof. Edgar Allen joined the band, and developed in the associated department of anatomy a wide field of research into the reproductive mechanisms of Rhesus monkeys—a field which was also being covered by Dr. G. Van Wagenen in a neighbouring laboratory. These three laboratories, housed more or less under the same roof, have in the past fifteen years been the world-centre for studies of primate biology. Prof. Yerkes has only recently come to the end of his term as head of the laboratory he founded. Under the tutelage of its new director, Prof. Lashley (one of the foremost world-authorities on psycho-physiology), the future of the department is more than assured.

Prof. Yerkes has given students of primate biology a number of comprehensive works on the behaviour of apes. The best known is his reference book "The Great Apes", a compilation of all recorded observations on the lives of these animals. In his new book "Chimpanzees: a Laboratory Colony", he does not provide a general account of knowledge about chimpanzees since, as he puts it, his book is neither comprehensive nor historical; nor does he provide an epitome of studies made in the laboratories under his directorship. What he has given us is an excellently illustrated book, written primarily from personal experience and from a personal point of view, which records various facts relating to the general behaviour, social behaviour, mentality and handling of chimpanzees in captivity.

The book opens with a brief account of the natural habitat of chimpanzees and with a statement about the means by which they are captured and the uses to which they are put in captivity. Then comes a general description of their mercurial changes in attitude and behaviour and of their different temperaments and individualities. The chapter which follows is a somewhat more detailed account of social interactions between ape and ape. This is succeeded by a careful record of the growth phases and reproductive physiology of the chimpanzee and of sexual relationships. All this constitutes Part 1 of the book. Part 2 is devoted to the subject of chimpanzee mentality. Perceptual capacities, ideational behaviour, learning, memory and symbolism are each discussed in detail. Part 3 is a unique statement of the best ways to house, feed and breed the animals under laboratory conditions. The material it incorporates has never before been put together in so useful a form, and it should prove of immense value to other students of primate biology.

Two central themes which Prof. Yerkes deals with at length are the part played by the striving for dominance in the social lives of these animals, and the level of their mental evolution. Dominance is defined in terms of the dominant individual—"one who takes priority of response over its companion and is able to satisfy its needs, desires, or whims to the total or partial exclusion of another's rights". This characteristic develops in childhood and is, as Prof. Yerkes shows, a major, almost *the* major factor in the life of the mature animal. Prof. Yerkes is, however, inclined to regard the principle of dominance not so much as placing a premium on selfishness but as an insurance against individual ineffectiveness. Whether dominated animals would take the same view, or be assuaged by the occasional instances in which a dominant ape shows kindness, could only be answered by the animals themselves.

Prof. Yerkes indicates that chimpanzees can be trained to act co-operatively in a task the reward of which is, say, a piece of fruit—although in such situations the animal of "superior social status will try to encourage and direct the assistance of its subordinate companion and also do its best to monopolize the reward". In Nature almost the only truly co-operative activity of chimpanzees is mutual grooming. All this leads Prof. Yerkes to define the outstanding social characteristics of the species as "infantile social dependence, with its urge to cling; childish social attachment, with its insatiable craving for companionship; and adolescent or mature dominance, with its persistent drive for social status—a higher place in the social hierarchy". This is a very fair statement of the position.

The drive for dominance in general puts the male above the female socially. Scales of dominance, however, are not permanent. When a female is on heat and sexually desirable she becomes less subordinate—largely through what may be generally described as sexual prostitution. "The mature and sexually experienced female trades upon her ability to satisfy the sexual urge of the male. Sexual accommodation is or may be habitually exchanged for such material or personal advantages as the possession of food, desired objects, comfortable quarters, opportunity for initiative, leadership, or freedom of action". In all this the chimpanzee appears to behave in very much the same way as the baboon.

In 'mentality' and the ability to deal with experimental problems, the chimpanzee appears, however, to be superior to baboons and other monkeys, although fundamentally, as Prof. Yerkes writes, there are no "significant contrasts" in their behaviour. Essentially chimpanzees differ from monkeys in their "readiness and degree of response to training, general adaptation to experimental and other requirements, ability to learn to co-operate with each other or with Man".

The mental gulf between chimpanzee and man is, of course, much wider than that between chimpanzee and monkey. For no amount of similarity in funda-

mentals of behaviour can make up for the ape's lack of articulate speech and symbolic processes.

Prof. Yerkes's book is a great achievement and a rich contribution to the literature of the Primates. Students of the subject once again stand deeply in his debt. S. ZUCKERMAN.

THE STUDY OF MORALE

The Structure of Morale

By Dr. J. T. MacCurdy. Pp. vii+224. (Cambridge: At the University Press, 1943.) 8s. 6d. net.

IN the speaking and writing on current problems of which there is to-day such an increasing spate, discussion of values of a non-material nature frequently introduces the use of the word 'morale'. It is then employed in a loose, indefinite fashion to cover a diversity of meanings. A serious study of the whole subject by a writer of standing, qualifications and experience comes very apt to the moment.

Warren, in his "Dictionary of Psychology", allows the more general application of the term to the attitude of the group, though permitting its use in speaking of the individual, and considers that it marks the degree of confidence, perseverance in work, and adherence to ideals. The behaviour of man as a human being has long since ceased to be that of an isolated unit and to an increasing extent become that of a member of a community. According to McDougall, the positive side of the group spirit depends on the existence in the mind of each component of a clear knowledge of the group, of his place in it, and of a sentiment of devotion to it. It is important to recognize that there is an inward source of authority based on the herd instinct, leading to social cohesion and co-operation.

Dr. MacCurdy is a university lecturer on the subject of psycho-pathology; called upon in the earlier days of the War to lecture on problems of morale to selected personnel, he has wisely chosen to be practical, concrete and direct rather than theoretical and discursive. Discussion of the multiple facets of this subject has required some explanation of the common psychological urges with particular reference to the group-mind and the implications of the part played by the herd instinct in the feeling, thinking and willing of mankind. To do so he has, of course, had to cover elementary ground, to re-state the trite and to enlarge the commonplace. But Dr. MacCurdy is never dull; he always has an appositeness of remark and a convergent simplicity interesting to the informed and instructive to the ordinary man.

This very broad approach is dealt with systematically by the author. First of all he gives some attention to the place of the individual, and has taken for this purpose the nature and effects of fear. He explains the factors incident upon the individual in his dual reactions as a unit and as a member of a community, showing neatly how a man can be both frightened and brave at the same moment. Stress is rightly laid on the identification of the self with the ideal of the group, the striving urge in this direction, and the increasing pride, nay pleasure, in the acceptance of another and higher responsibility.

Perhaps the most attractive chapters in the book come in the second section, which deals with the basic principles of social life. It is to be remembered that the feelings seeking expression in the face of any given event are not the mere outcome of a momentary impulse; they represent the focus, the apex, of a wealth of interlocking, often contradictory factors stretching far back into the heredity and history of the individual. All sorts of influences—education, tradition, climate, geography, health, contacts, etc.—provide threads reaching down to and governing the immediate response. In considering all these qualities involved in the make-up of morale, Dr. MacCurdy is able to discuss the variables, such as national and religious sentiments, different scales of values, loyalties, leadership, moralities and so on. He has some very apposite remarks to make on the growth and development of national differences and tendencies in this respect, cultivated and shown consciously or not. Though he is quite ready to criticize details of our own national traits and aspirations, it is satisfying to find that he is able to come to a dispassioned judgment against the fundamentals of the German.

That confidence in the outcome which is a constituent part of morale depends very largely upon the feeling about the organization behind the effort. This again in many if not all of its details has implications of importance. In the third section of his book Dr. MacCurdy takes up the various aspects coming under the head of organization, liaison, departmentalism, caste, science and its place, democracy, dictatorships, public service: many, in short, of the difficulties inherent in the mere necessity of some sort of coordination for mutual and common ends. He is thus able to separate out and dissect in detail, but always in relation to the common factor, the multiple problems involved in our relations with our fellow-men calling for collective and accepted arrangement.

The "Structure of Morale" is a sound and competent piece of work. Written by a man of special experience and opportunities, it succeeds, though dealing largely with subjects of a strong technical flavour, in explaining with clarity and instructing with interest upon the changing values of a changing world. It is full of common sense and clear thinking. It will be read with advantage by everyone, from chief executive to railway clerk, who has any vision for things beyond the close horizon of his petty personal interests. Even these are involved, for they can never be quite disentangled from what R. L. Stevenson has so aptly called "a municipal fitness".

JOSEPH GEOGHEGAN.

FLUCTUATION IN ANIMAL POPULATIONS

Population Dynamics and Adaptive Evolution of Animals

By S. A. Sewertzoff. (In Russian.) Pp. 316. (Leningrad: Academy of Sciences U.S.S.R. Moscow, 1941.) 11 roubles.

PROBLEMS of fluctuation in numbers in animal populations are of direct interest both to those concerned with the exploitation of natural animal resources (fish, game, fur-bearing animals), and to students of evolution. Theoretical research on these problems is visualized by the author mainly as investigation of facts illustrating the Darwinian theory of the struggle for existence. According to him the overwhelming importance of the struggle for existence is overlooked by the majority of theoretical biologists, and this accounts for the spread of such idealistic theories as hologenesis, Lamarckism, nomo-

genesis, etc., while a tendency to ignore Darwinian ideas is characteristic of 'bourgeois science'. Such a view of Western biology may cause some surprise, as it is scarcely justified by the modern trends in its development, which appear to have remained largely unknown to the author. In fact, when discussing evolutionary theories later in the book, he directs his polemics against O. Abel and Beurlen, neither of whom can be called very modern, or typical of Western science.

The first part of the book is introductory and contains a review, which is not very up to date, of the basic principles of population dynamics, such as the curves of population growth; specific constants of reproductive ability; longevity curves; etc. The second part, occupying nearly half the book, is the most interesting one, as it comprises detailed analyses of fluctuations observed in populations of various game birds and animals, mainly in the Gatchina game reserve, where exact records of the game bred and shot have been kept for twenty-five years (1884–1909). Other data are those on the dynamics of the bison and other game in the Bialowiezh forest in the period 1809–1916; of the seal population in the Pribyloff and the Komandor islands in 1912–1932; of wolves in Central Russia in 1917–1924; of squirrels in 1891–1908; of hares in Russia in 1825–1898; of voles and other rodents; etc.

The third part is closely linked with the second, as it is given to the discussion of the theories of population dynamics. The curves of increase in populations and of mortality of every species are, according to the author, as characteristic of the species as its morphology or physiology. Fluctuations in populations are due to a gradual increase, regulated by the action of predators, which, however, can only influence the length of the cycle but are never able to overtake the increase in the population of the prey, and thus to cause the collapse of a cycle. The collapse is always sudden and is usually caused by an epizooty, in the spread of which the density of the population is a most important factor; in less frequent cases, the collapse may be due to a climatic catastrophe. This sudden reduction in the prey population causes a reduction in the number of predators due to lack of food, and this makes a new increase of the prey possible. The author's theory, therefore, only partly coincides with those of Volterra and of Elton; a possible direct correlation between population cycles and climatic cycles is rejected by the author, practically without argument.

The fourth part, entitled "Ecology and the Evolution Theory", begins with an attempt to analyse the facts of population dynamics against the background of the Darwinian struggle for existence, and the well-known conceptions of life-form, ecological niche, biotic potential, etc., are discussed. This leads the author to consider the evolution of species in their relations to environment, but instead of analysing this problem with concrete ecological data, he transfers the discussion to the question of adaptations, not of individual species, but of large phyletic groups, and many pages are devoted to Osborn's and A. N. Sewertzoff's theories of adaptive radiation and evolution. This chapter is followed by one dealing with the problem of longevity and mortality in different groups, and a conclusion is reached that long-lived species are less fertile than the short-lived ones, but their mortality is also lower and their numbers less subject to fluctuations. This interrelation permitted the author to develop a mathematical formula showing that the fertility of a species is a logarithmic function of its longevity. The formula has enabled him to construct a series of species of mammals, birds, reptiles and fishes, which make it possible to arrive at definite conclusions with regard to the relative intensity of the struggle for existence in these classes. A special chapter is devoted to checking the general conclusions on mammals; the evolutionary history of the class is recapitulated and found in harmony with the author's theories. In the concluding chapter the author rather suddenly reverts to the practical aspect of the subject and supplies a somewhat sketchy account of the influence of man on populations of wild animals, and also points out the importance of a knowledge of the laws of population dynamics for those concerned in fisheries, game-keeping, etc.

The book leaves a very mixed impression. Its purely ecological chapters are most interesting because of the author's dynamic approach and his masterly dialectical analysis of a mass of valuable data from Russian sources, but his attempt to justify the life-long morphogenetic and phylogenetic work of his brilliant father, A. N. Sewertzoff, by its somewhat remote connexion with purely practical problems, appears scarcely necessary. Unusual features of the book are an almost complete lack of reference to the genetic aspect of population dynamics and of evolution; and repeated protestations of the Darwinian orthodoxy of the author's views. The bibliography is rich in Russian references of great value to ecologists and population students, but there are no references to publications in other languages after 1937. B. P. UVAROV.

AN UNSCIENTIFIC HISTORY OF SCIENTIFIC THOUGHT

From Copernicus to Einstein

By Hans Reichenbach. Translated by Ralph B. Winn. Pp. 123. (New York: Philosophical Library, Inc., 1942.) 2 dollars.

ON the jacket of this book the publisher states that "this is a simple but scientific history of ideas and discoveries that have led to the formulation of the theory of relativity. . . . The wealth of ideas contained in it tend to make it a distinguished contribution to scientific thought. It is well illustrated with charts and diagrams. The book is especially intended for the scientific as well as amateur astronomer and physicist." The reader will soon discover that these statements are quite unjustified; that the book abounds with erroneous statements, that the historical perspective is often wrong, that the wealth of ideas is conspicuous by its absence and that the translation is so bad that it is sometimes impossible to understand what is meant. The illustrations consist of eleven crude diagrams.

In the first few pages, for example, views are ascribed to Ptolemy that are much earlier in point of time. The author states that the "De Revolutionibus" of Copernicus appeared in 1546, after the death of Copernicus, and that Copernicus read the proofs on his death-bed; Copernicus never saw the proofs, and the book appeared in 1543, a copy reaching him a few days before his death. It is not correct that "the Copernican theory offers a very exact calculation of the apparent movements of the planets", nor that this was one of the reasons that led to its accept-

ance: Copernicus himself said that he would be delighted if he could make his theory agree with observation within 10′. It is not true that Copernicus was able to break with an old belief "only because he had at his disposal a considerable amount of accumulated scientific thought and scientific data". The statement that with the astronomical instruments of to-day angles can be measured "within one hundredth of a second of the arc" shows a lack of appreciation of the errors of observation. It is not correct to state that Copernicus "was of the opinion that the solar system virtually exhausted the space of the Universe"; Copernicus asserted that the stars were at an immense distance, but left the question whether the world was infinite and without bounds for philosophers to discuss.

The account of the work of Tycho Brahe and Kepler is misleading. Kepler was able to prove that the orbits of the planets are elliptical because Tycho had not restricted his observations of the planets, as his predecessors had done, mainly to the times near opposition, but had observed them right round the heavens; this is not mentioned. The statement that Kepler "discovered through mere measurement also other laws of planetary motion, called after him 'the Kepler's laws'" gives a poor idea of Kepler's long and laborious investigations. It is not correct that to Copernicus and Kepler the stars "were tiny dots in the sphere of heavenly matter". Giordano Bruno was not the first person to assert that the firmament was infinite; this was stated by Thomas Digges, from whom Bruno probably adopted the conception. Galileo did not make the first serviceable telescope, and he did not see Venus as a sickle-like shape, but as a crescent. He did not designate the major satellites of Jupiter as the "medizeic planets". To state that he discovered that "all bodies fall equally fast" is inaccurate. The statement that "fate allotted to the English physicist Isaac Newton an outstanding role in the history of the natural sciences of the described period" is a poor tribute to the genius of Newton.

A few specimens of the translation will suffice to show its crudeness. "Electrical waves are advancing fields which should not be regarded as bound to a material medium. They are waves in which electricity continually alternates between positive and negative. Yet they are not dependent on the ups and downs of small material particles, but move quite independently through space. They thus have qualities found by the science of optics in the slow course of experimentation with light." "Such reflections were entertained with regard to ether and in connection with astronomical relations. As light traverses the world's space, ether must fill it like a great mass of water in which planets float like isles. Insofar as planets move around the sun, they must be characterised by a different state of motion from that of ether. Thus one comes to the assumption that the velocity of light, as measured on a planet like the Earth, must vary with direction, simply because ether is understood as a substratum of light waves and only with regard to it can the velocity of light receive its natural value". "What is maintained by Einstein with regard to light goes, therefore, for all electrical waves of which light is but a representative. But according to our knowledge of the internal structure of all substances, there are basically only two ways of transferring power from body to body; gravitation and the electrical wave. Every other manifestation of force is composed of them. If they both move with the velocity of light, as Einstein contends, then a slowing up may occur within the atoms of the body, when the power runs in a zig-zag course; but it can never be accelerated. Einstein's law of the limit character of the light-velocity means thus nothing other than a formulation of the fact that light represents one original form of the transfer of action, the other representing an equal speed limit".

The quotations will suffice to show that the book cannot be recommended. H. SPENCER JONES.

LANGUAGE IN THE MAKING

The Gift of Tongues

By Prof. Margaret Schlauch. Pp. ix+342. (London: George Allen and Unwin, Ltd., 1943.) 12*s*. 6*d*. net.

MARGARET SCHLAUCH is a professor of English at New York University and teaches Chaucer, medieval literature and language. In the "Gift of Tongues", however, she has directed attention to the study of linguistics for the layman. The matter is so varied in style and content that it is difficult to comment on the book as a whole. Generally, it is well written and reads easily; much of the reader's enjoyment comes from a liberal sprinkling of sly humour which never obtrudes. Among the many subjects dealt with by Prof. Schlauch are the early origins of language, the use of names in magic, the evolution of written language through pictographs, ideographs and hieroglyphs to fixed alphabets and the study of semantics.

The possibilities of basic English as an international language is discussed in a chapter dealing with the history of the English language. A section on grammar gives a brief outline of the principles of sentence construction in the Aryan family of languages and then proceeds to show that our own system is, after all, but one system, based largely on Latin. An interesting account of the emotive qualities of words leads on naturally to the use and need of linguistic knowledge in studying some modern poets like James Joyce, Gerard Manley Hopkins, Gertrude Stein, Hart Crane and others whose works are reputed to be 'difficult' because of their deliberate use of verbal distortions, puns, overtones and double shades of meaning. The work of modern poets in using words in their original meanings and free from the impediments which have obscured their original meanings is also considered.

Men of science, as well as Mrs. Malaprop and other *arrivistes* in language, would find much to interest them in the chapter concerned with the social aspects of language and its significance in class, superstition, and politics. In this connexion it is easy enough to agree with Prof. Schlauch that "linguists will gain and give most when they unite the traditional scrupulous regard for scientific method with vivid and realistic awareness of social milieu and its challenging problems. To do this they will have to receive help from, as well as give it to, other disciplines such as sociology and psychology", as well as her further remark that "no part of language study offers better occasion for scientific collaboration than the investigation of meanings against a social back-ground".

The book is thoroughly annotated and contains a well-ordered and lengthy bibliography. The series of questions and illustrations at the end would be useful as diversion for the layman and exercise for the student. T. H. HAWKINS.

CHEMICAL ASPECTS OF THE VISUAL PROCESS

By DR. R. A. MORTON
University of Liverpool

THE chemistry of photo-reception remains obscure in spite of a vast literature, particularly rich in biophysical data; indeed it is doubtful whether on the chemical side present theories are more than the merest scaffolding. Recent statements by well-known workers display a confidence about the nature of visual purple (rhodopsin) which it is not easy to share. It is said to be "safe to assume that visual purple is a conjugated carotenoid-protein" (Hecht[1]); rhodopsin "is a conjugated protein with a carotenoid prosthetic group called retinene; it is estimated that one molecule contains 10 prosthetic groups and that each such group contains one molecule of vitamin A" (Mitchell[2]). "Rhodopsin is a rose-coloured carotenoid-protein, in aqueous solution its absorption spectrum consists of a single broad band maximal at 500 mμ. In light it bleaches in a succession of photochemical and thermal reactions to orange and yellow products, liberating *in the process* the carotenoid retinene" (Wald[3]). "No doubt, therefore, the A vitamins are of importance for the formation *of the chromophoric group* of the visual purple molecule, even though it may not be possible at present to describe the nature of this relationship" (Granit[4]).

The existence of retinene was revealed by the work of Wald. It is defined by him as the substance which gives rise to a blue-green colour with chloroformic antimony trichloride, characterized by a sharp absorption band at 664 mμ. Retinene disappears when intact dark-adapted retinas are illuminated and is replaced by vitamin A ($\lambda_{max.}$ 620 mμ in the antimony trichloride colour test). The cycle:

$$\begin{tikzcd} & \text{Rhodopsin} \arrow[dr, "\text{light}"] & \\ \text{vitamin A} + \text{protein} \arrow[ur, "2"] & & \text{retinene}_1 + \text{protein} \arrow[ul, "1"'] \arrow[ll] \end{tikzcd}$$

plausibly summarizes the role of vitamin A in preventing abnormally slow adaptation to dim light (scotopic vision). The discovery of vitamin A_2, and of the pigment porphyropsin in the retinas of freshwater fishes, led to the idea of a parallel cycle:

$$\begin{tikzcd} & \text{Porphyropsin } (\lambda_{max.}\ 532\ m\mu) \arrow[dr, "\text{light}"] & \\ \text{vitamin } A_2 + \text{protein} \arrow[ur, "2"] & & \text{retinene}_2 + \text{protein} \arrow[ul, "1"'] \arrow[ll] \end{tikzcd}$$

With the antimony trichloride reagent, vitamin A_2 gives a colour with $\lambda_{max.}$693 mμ and retinene$_2$ a colour with its maximum absorption at 706 mμ. Direct absorption spectra of solutions containing retinene$_1$ and retinene$_2$ reveal maxima at 387 and 405 mμ respectively, which are plausibly but not conclusively attributed to these substances.

Wald's observations created an interesting and promising situation, but as has happened before in visual purple research, progress appears to have halted. The reason is probably a lack of working hypotheses. No suggestion has been hazarded as to the chemical relationship between the vitamins A and the retinenes. No mechanism has been advanced to account for the conversion of vitamin A ($\lambda_{max.}$ 325 mμ, practically colourless in dilute solution) to the rose-coloured visual purple. No explanation is available of the fact that in studying the photo-decomposition of visual purple *solutions*, vitamin A could not be found at any stage (Krause and Sidwell[5], Wald[6]).

Vitamin A, a fat-soluble alcohol $C_{20}H_{29}OH$, is not known to form *p*H-sensitive derivatives: yet visual purple undergoes photo-decomposition to yield a succession of products, all of which are *p*H-sensitive:

$$\underset{(\lambda_{max.}\ 500\ m\mu)}{\text{visual purple}} \rightarrow \underset{(\lambda_{max.}\ 470\ m\mu)}{\text{transient orange}} \rightarrow \underset{(\lambda_{max.}\ 445\ m\mu)}{\text{indicator yellow}} \rightarrow \text{colourless products}$$

(Lythgoe and Quilliam[7], Wald[6]).

According to Wald, a succession of changes occurs, and though the spectrum of rhodopsin itself is unaffected by *p*H changes, the spectra of all stages of bleaching are highly *p*H-labile. "Rhodopsin apparently does not possess an acidic or basic grouping in close association with its chromophore, but such a grouping is exposed as a first result of irradiation (cf. Lythgoe). The effects of *p*H change on the absorption spectra of bleached products are in some cases large and peculiar, probably because they involve complicated mixtures of pigments."

It has been shown that the quantum efficiency of the primary photochemical process in the decomposition of visual purple is about unity and the molar extinction coefficient (at 506 mμ) is $2{\cdot}3 \times 10^4$ (Dartnell, Goodeve and Lythgoe[8]).

In itself this is scarcely consistent with a 'carotenoid' prosthetic group, since $\varepsilon_{max.}$ is 5×10^4 for vitamin A and 1×10^5 for β-carotene.

Vitamin A deficiency not only delays dark adaptation in scotopic (rod) vision but also very definitely affects photopic (cone) vision. The duplicity theory is firmly established and vitamin A is concerned in both mechanisms. Nothing, outside the problems of vision, is known about vitamin A or its derivatives to indicate abnormal photo-sensitivity, and the idea that the *chromophoric group* of visual purple is retinene or any other vitamin A derivative does not compel assent. The chromophoric or prosthetic group may well be entirely different; it may be an unknown or a known substance.

In fact, it has already been suggested that riboflavin (or a related compound), which is known to occur in relatively large amount in the eye, may "take part in the visual processes by means of its photo-chemical properties such as fluorescence and light-sensitivity" (Adler and v. Euler[9]). The photochemistry of riboflavin, of its phosphate and of the yellow enzymes is complex; there is a sequence of changes, *p*H-sensitive and oxygen-sensitive products being formed. "If the flavin of the retina is associated with colour vision, it is thought probable that the change of the flavin to a primary photo-body furnishes the nerve stimulation. The irreversible change of the photo-body to deutero-riboflavin, which would be a loss of valuable flavin is prevented by O_2 in the retina" (Theorell[10]). That flavin is in some way connected with the visual process seems clear from Pock-Steen's report that twilight blindness in 'leiodystonia' and sprue was alleviated by riboflavin but not by vitamin A. No attempt seems to have been made to reconcile the 'flavin' and 'vitamin A' hypotheses.

Of the possible changes which vitamin A (delivered to the eye via the blood stream as free alcohol $C_{19}H_{27}.CH_2OH$) could undergo, the first to be considered is clearly:

$$C_{19}H_{27}.CH_2OH \xrightarrow{-2H} C_{19}H_{27}.CHO.$$

This change is physiologically plausible. Unfortunately, vitamin A aldehyde has not been prepared, although Heilbron and his colleagues[11] tried to make it from the alcohol by the use of Oppenauer's method. Instead, they obtained $C_{23}H_{32}O$, probably $C_{19}H_{27}CH{=}CH.COCH_3$ ($\lambda_{max.}$ 401 mμ, antimony trichloride colour test 646 mμ) and $C_{19}H_{25}CHO$ (one additional double bond in the terminal six-membered ring). The aldehyde showed $\lambda_{max.}$ 401 mμ and a colour test $\lambda_{max.}$ 740 mμ. The reduction product $C_{19}H_{25}.CH_2OH$ gave $\lambda_{max.}$ 359 mμ, antimony trichloride colour test, 728 mμ. In attempting to judge whether the retinenes resemble the hypothetical vitamin A or A_2 aldehydes, it is necessary to recall a peculiarity of the colour tests. Vitamin A with antimony trichloride shows $\lambda_{max.}$ 620 mμ with a pronounced inflexion near 583 mμ. Colour-test inhibitors (for example, 7-methyl indole) suppress the 620 mμ band, and the 583 mμ maximum is revealed. Similarly, the vitamin A_2 colour test shows absorption maxima at 693 mμ and 650 mμ under certain conditions. The ease with which vitamins A and A_2 can be made to exhibit either of two maxima in the colour test at once raises the question whether the observed maxima for retinene$_1$ and retinene$_2$ are respectively comparable with the longer or shorter wave-length maxima :

	$\lambda_{max.}$ mμ	Antimony trichloride colour test maxima	
Vitamin A_1	325	620 and 583 mμ	
Vitamin A_2	350	693 and 650	
Retinene$_1$	387		664
Retinene$_2$	405	706	
$C_{19}H_{27}CH{=}CH.COCH_3$	401		646
$C_{19}H_{25}CHO$	401	740	
$C_{19}H_{25}CH_2OH$	359	728	

Two points emerge : first, the importance of preparing vitamin A aldehyde ; and second, the need for a full study of the colour test. The ultra-violet maximum for the aldehyde might be expected to fall near 360–370 mμ.

I have observed a 664 mμ chromogen (*a*) in extracts from *aged* processed human blood plasma and (*b*) in a fraction from bovine serum. In both cases the chromogen was probably an artefact. It has also been obtained by the oxidation of pure vitamin A but much contaminated with other products. Optimum conditions are elusive, but three workers (T. W. Goodwin, R. H. Creed and myself) have repeatedly seen the band, using CrO_3 or $KMnO_4$. Pure vitamin A (0·05 per cent) in cyclohexane rapidly decolorizes aqueous $KMnO_4$ (0·25 per cent in amounts up to 30 per cent of the volume of vitamin solution) on shaking in the cold in the presence of a little 5 per cent H_2SO_4. The supernatant cyclohexane solution is pipeted off and tested with the $SbCl_3$ reagent. With small amounts of permanganate the blue colour is greatly weakened; with increasing amounts the colour changes through purple to blood-red. Using sufficient of the cyclohexane solution, colour-test maxima at 664, 615 and 565 mμ can be seen, with a further band at 642 mμ appearing slowly. The first band is not always easy to obtain, but its detection fits into the pattern of facts. Acknowledgment is made to Prof. T. B. Davie and to Drs. F. H. Carr and T. H. Mead for material and to Prof. T. P. Hilditch for suggestions.

The possibility that vitamin A might be dehydrogenated to the aldehyde under physiological conditions is not unreasonable in the light of what is known of such enzyme systems as those involving di- or tri-phosphopyridine-nucleotides, but it affords of itself no hint as to the origin of colour in rhodopsin. On the other hand, it possibly fits the failure to find vitamin A in the decomposition products of visual purple solutions. Suppose that in the intact retina, vitamin A in equilibrium with its aldehyde occurs as a part of, or in proximity to, visual purple. The process of extracting pigment or hardening the retina would 'freeze' the equilibrium. In the dark-adapted retina this might well be very much on the side of the aldehyde, and in the absence of functioning enzyme systems the aldehyde might be expected to decompose slowly but irreversibly by oxidation.

Now the "main chemical alteration which occurs in the retinal tissues on exposure to light is a general tendency to become acid. . . . The degree of acidity varies directly with the intensity and duration of the exposure to light and is greatest with yellow-green light" (Duke-Elder[12]). Irradiation involves the formation of phosphoric acid which disappears in the dark (Olmsted[13]). The identification of phosphoric acid as a part of the photochemically initiated sequence of changes is a further complication to the 'carotenoid-protein' hypothesis.

If there are objections to ascribing the visual purple absorption curve to a 'carotenoid', there are also difficulties in the suggestion that the chromophore is a flavin. The various yellow enzymes (containing alloxazine-nucleotides) all show maxima near 465, 380 and 275 mμ, but the visible absorption is too low both in respect of $\lambda_{max.}$ and $\varepsilon_{max.}$ to fit the prosthetic group of visual purple.

Absorption maxima of yellow enzymes.

Cytochrome reductase	275, 385, 455 mμ
'Old' yellow enzyme	275, 380, 465
'New' yellow enzyme	275, 377, 455

(Haas, Horecker and Hogness[14]). There is, however, no doubt that a marked inflexion occurs near 490–495 mμ, corresponding with a somewhat masked absorption band (cf. Theorell and Haas[15]).

Early in the work on riboflavin it was observed that reduction in 10 per cent hydrochloric acid gave an intense red intermediate phase ($\lambda_{max.}$ 490 mμ) also recorded for alloxazines like lumiflavin (Kuhn and Wagner-Jauregg[16]; Stern and Holiday[17]). This semiquinone formation has also been shown to occur under much more physiological conditions when yellow enzyme is reduced in the presence of a large excess of tri-phosphopyridine-nucleotide (Haas[18]). The red ferment is thus probably a flavin-pyridine-nucleotide, both prosthetic groups being bound to protein.

	$\lambda\lambda_{max.}$	
Yellow enzyme	465	380 mμ
Red phase	475	360

This red ferment is the closest physiologically plausible analogue of visual purple which is so far known. It requires, however, a reducing agent which shall effect an easily reversible partial reduction at the alloxazine ring. The 'flavin' and 'carotenoid' functions can be married by attributing this reduction to vitamin A aldehyde. On this basis the aldehyde, accumulating sluggishly through the action of, for example, tri-phosphopyridine-nucleotide on vitamin A, conditions the speed of visual purple regeneration. The primary photochemical process will not be a reversal, but a partial direct oxidation to yellow enzyme, and vitamin A aldehyde will not be affected. Hence retinene could be obtained from dark-adapted retinas, and in visual purple *solutions* would be oxidized away. The alloxazine-nucleotide oxidation-

reduction system, moreover, affords a rational basis for electron liberation.

Any adequate working hypothesis for the visual process requires *stages* in the oxidation-reduction system. According to the work of Kuhn and Ströbele[19], such stages are demonstrable with araboflavin :

		Oxygen uptake in regenerating 1 mol. flavin
Flavin	yellow	0
Verdoflavin	bronze-green	0·25
Chloroflavin	grass-green	0·50
Rhodoflavin	carmine-red	0·75
Leucoflavin	colourless	1·0

In the case of "photo-hepato-flavin", Stern and Holiday record :

		$\lambda\lambda_{max.}$
Holoquinone	neutral	364, 440 mμ
,,	in 0·2 *N* HCl	267, 385 mμ
,,	in 0·2 *N* NaOH	263, 352, 442 mμ
Semi-quinone	in 0·2 *N* HCl	358, 490 mμ

It is conceivable that the 387 mμ maximum recorded by Wald for retinene is really due to a flavin concomitant and not to the 664 mμ chromogen. It is a curious fact that the lens emits a pale greenish-yellow fluorescence, the most effective spectral region for its production being 370–390 mμ, maximum 385 mμ (Hoffmann, quoted by Duke-Elder[20]). I have obtained from horse lenses a chloroform-soluble material absorbing in this region and giving a strong sky-blue fluorescence (possibly due to dimethylalloxazine).

Vitamin A aldehyde could be replaced by vitamin A_2 aldehyde without fundamentally affecting the 'flavin' mechanism for scotopic vision. It could likewise function in photopic vision. Here it is not irrelevant that the optical properties of planar molecules are known to be susceptible to change with dimer and polymer formation, and with molecular orientation both with respect to surfaces and molecular axes.

To summarize this discussion, an attempt has been made (1) to account for the evidence that poor scotopic vision may follow from avitaminosis-A *or* -B_2 ; (2) to suggest a mechanism for the intervention of vitamin A (or A_2 in freshwater fishes) ; (3) to explain why vitamin A is not obtainable from visual purple solutions ; and (4) to devise a mechanism which allows vitamin A to participate, albeit indirectly, in both photopic and scotopic vision, without leaving the photochemical problem in mid-air.

The whole range of trustworthy data on visual processes and perhaps even of bioluminescence will need to be fitted into an acceptable theory. It is of small consequence if the suggestions now made turn out to be inadequate as new facts are gathered. The important thing at this stage is that the chemical aspects of the problem should be focused more sharply, and the difficulties faced.

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STATISTICS IN SEDIMENTARY PETROLOGY

By DR. P. ALLEN
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RECENT publications show that at long last there is a flood-movement in British geological research towards the accumulation of increasingly precise quantitative data. The transition from the qualitative phase, painfully slow at first, has lately been accelerated in most branches of the science. This limited progress is especially marked in sedimentary petrology, where Fleet, Butterfield, Smithson and Walder have raised a banner which all must surely follow.

Without a doubt this vigorous movement marks only a beginning. Already some of its protagonists, wallowing in a mire of seemingly endless figures, are beginning to question the wisdom, and indeed the reliability, of their laborious endeavours. Attempts at extrication by crude mathematical methods (concerning the reduction and not the reliability of data) have met with little success. Other petrographers, less desirous of reaching immediate conclusions, are content merely to amass information of unqualified precision in the hope that one day it may prove useful.

All the present difficulties and discrepancies have one common underlying cause. They are due entirely to the widespread inability of geologists first to recognize, and secondly to deal with, the various types of population commonly encountered in petrological research. No matter if these populations are finite or infinite, and irrespective of which sedimentary variates they concern, their behaviour and its repercussions remain uninvestigated and almost completely ignored. Yet, to quote the most fundamental example, all petrological work, even that concerned with the smallest finite populations, relies on sampling for its practicability. Consequently, though the distinction between some of the statistics actually used, and the parameters estimated, may often be recognized, no allowance is ever made for it—the penumbræ of error darkening our petrological morass are left well alone ! Yet it is idle merely to record the useless fact that zircon reaches a mean size of "50 μ" in a certain locality ; statement of the statistic in conjunction with its (qualified) standard error—as "50 μ ± 3 μ"—conveys information of considerable geological value.

In consequence of the shortcomings outlined above, interpretations drawn from quantitative petrographical data usually either do not justify the laborious methods used, or (especially when 'conclusive') are largely unwarranted. The former situation involves waste of data and both involve waste of time. Indeed, I know of no geological work (published in Britain) that contains one conclusion stated as an honest mathematical probability. I am also unaware of any paper devoted mainly to quantitative information which is enlightened by a really comprehensive account of the sampling and analytical techniques employed. Truly, appraisal by the sceptic is normally quite impossible. Consistently with this state of affairs, investigations planned to achieve desired degrees of precision—indeed degrees of precision themselves—are practically unknown in British geology. The present difficulties are all the more surprising when we consider that the mathematical techniques necessary for their removal have existed

for some time. One can only conclude that for three decades most geologists have worked in complete oblivion of the progress of statistical science.

During the past five years, much work in the Department of Geology at the University of Reading has been devoted to the application of statistical methods to geological problems, especially those of a petrological and stratigraphical nature. In the sphere of sedimentary petrology the mathematical techniques have already more than justified their adoption.

Selection of Fields of Study

Statistical control exerts its first influence in the selection of fields of study. The preferable fields are those which permit detailed investigation of (1) the areal petrographical characters of widespread but thin horizons (less than 6 in. thick), and (2) the vertical petrographical successions in single localities. By the first approach an attempt is made to treat certain selected geological 'moments' separately throughout their accessible extents, and so to elucidate the *spatial* distributions of their petrographical characters. By the second, the distributions *in time* of petrographical characters are studied at selected points. In such a manner the invalidating effects of the two types of distribution upon one another may be minimized each in turn. Unfortunately, the nature and number of actual and potential exposures very often leave the sedimentary petrologist no choice but to concentrate largely upon one or other of the two viewpoints. When quarries and other sites are normally small but very numerous (as in the Wealden rocks of south-east England), horizonal studies often yield the more valuable results; when they are extensive but few (as in the Tertiaries of the Isle of Wight, now being studied by my colleague Miss P. S. Walder) investigation of the petrographical sequence in time frequently appears to be the more promising. I recently completed an areal study of the Top Ashdown Pebble Bed[1] in the Weald of Kent, Surrey and Sussex, using an arbitrary 2-in. horizon situated 4 in. down in the underlying sandstone as 'control'. Since the efficacy of statistical methods has been most fully tried out on this sediment, particular reference thereto is made in the present outline.

If a horizonal study has been decided upon, the petrologist should next ensure that the sampling on which it is to be based will be as nearly random as possible. The distribution of satisfactory exposures usually limits him in this respect, because, being controlled by factors other than chance, it is not necessarily a random one. Secondary sampling from them at random is seldom possible either, for the exposures at any one widespread horizon less than 6 in. thick are usually all too few at the start. The sandpits and openable sites at the Top Ashdown Pebble Bed horizon were apparently distributed according to factors quite unrelated to the petrographical characters of the bed. The risks inherent to an assumption of randomness, being therefore considered minimal, were ignored, and attention was merely focused upon ensuring random sampling within the sites located.

Choice of Statistics

Preliminary analysis of a few field samples (by the usual methods of gravity separation, and counting of *entire* residues) indicates the range of statistical values likely to be necessary for the subsequent sample and horizonal characterizations. In general, the constituents of sediments are found to be most easily dealt with through separate consideration of two or three fractions, namely, (1) the allogenic pebble suite (when present), (2) the allogenic light and heavy grain suites, and (3) the authigenic light and heavy suites. The minimum quantitative requirement is that in every field sample each of these five suites shall be fully characterized by statistics relating to frequency, abrasion, grade size and sorting. The frequencies (expressed as percentages) of all pebble and mineral grain species, varieties and other distinctive types, should be determined, together with their 'errors'. The degrees of abrasion are best expressed as the percentages of euhedral, subangular, angular and rounded individuals (suitably defined), average size as their arithmetic mean sizes (based on measurements of intermediate axes), and degrees of statistical sorting as the coefficients of variation derived from the data yielding their means. Calculation of errors is of course necessary in all cases.

During the study of the Top Ashdown Pebble Bed, the determination of the grade sizes and degrees of sorting of all the species, varieties, etc., in every subsample was found to be too time-consuming. This difficulty was overcome in the case of the allogenic heavy suite by using the values pertaining to zircon (probably the most stable mineral) as indexes typifying the whole suite. The validity of the method was confirmed by replicate analysis and by detailed comparisons with other species. The allogenic heavy grain suite of each Ashdown field sample was thus finally characterized at least by (1) complete frequency analysis, (2) the 'zircon abrasion index' (equals per cent of euhedra among the zircons), (3) the 'zircon size index' (equals the mean size of zircon), and (4) the 'zircon statistical sorting index' (equals the coefficient of variation of the zircon grain-size distribution).

Estimation of Minimum Subsample Size and Standard Errors

The field sampling and characterization designs having been settled, it is necessary to estimate the minimum number of pebbles or grains in the subsamples pertaining to each suite which will be necessary to achieve sufficient accuracy for studying the variations anticipated in the various populations of the sediment. Analysis of a few subsamples of arbitrary sizes from widely different sedimentary grades usually suffices for a provisional estimate. In the case of the Top Ashdown Pebble Bed, the subsample sizes were standardized at greater than 200 for pebbles and greater than 1,000 for grains.

In order to establish the degrees of significance of the chosen statistics and to recognize when significant differences exist between them (within the aims of the investigation), the petrologist must be able to estimate their associated 'errors'. Because these (best expressed in the form of standard errors) necessarily always embody components due to random sampling (SE_r) and experimental treatment (SE_e) they may be termed 'total standard errors'. Their magnitude will vary with the project and the consequent unit of comparison—normally either the subsample, the 'patch' or the 'locality'.

1. *Standard Errors of the Subsample* (SE_s). During the preliminary work it is convenient first to investigate the total standard errors (SE_s) of statistics referring to the adopted subsample alone. Values for these, in terms of their component sampling errors, may be obtained from series of replicate analyses of homogenized material drawn at random from the known grade-size range of the sediment. For pur-

poses of improvements in laboratory technique, SE_s may also be calculated for each species from the data. In the case of frequencies, significant differences between the total and the sampling errors within series are best tested by χ^2, using Brandt and Snedecor's formula[2]. Graphed against frequency, the values (k_s) of the ratio SE_s/SE_r determined for each species may be used in the subsequent assay as a basis for estimating the total errors from the sampling errors of single values. In this way the otherwise inevitable replication of each sample in the main investigation is obviated. SE_s is most necessary for use in the tests of significance involved during the study (by concentrated sampling) of local small-scale petrographical variation, or 'patchiness'.

2. *Standard Errors of Patchiness* (SE_p). Combined with the thin sampling normally forced upon petrologists, SE_s is not, unfortunately, necessarily large enough to deal with the establishment of more widespread changes, such as the recognition of minor petrographic 'regions'. Estimation of a sufficiently comprehensive error, the 'standard error of patchiness' (SE_p), allowing for small-scale variation within the sediment, may be conducted in the same general way as that of SE_s, but using instead the ratios (k_p) derived from random series of replicate samples of *unmodified* material, the latter being taken at random from small horizonal areas of constant size. For the Top Ashdown Pebble Bed these areas were fixed at ½ sq. ft.

3. *Standard Errors of Locality* (SE_l). When horizonal sampling is thin, and broad petrographic regions are to be established, the unit of comparison strictly becomes the locality, and an error even more comprehensive than SE_p is needed. One such, the 'standard error of locality' (SE_l), may be estimated as before from its component sampling error by means of specific factors (k_l) obtained from preliminary replicate sampling within 'localities'. During the study of the Top Ashdown Pebble Bed, a 'locality' was defined as a quarry of a certain size. Unexpectedly, however, analysis of variance showed that none of the values obtained for k_l significantly exceeded the corresponding k_p's, and SE_l was consequently taken as approximately equal to SE_p.

Manipulation of Standard Errors

The three standard errors may be manipulated during the subsequent work in the usual way, the particular error used and the level of significance chosen varying with the aims in view and the sampling concentrations achieved. The assumption that the distributions of the variates concerned are normal must necessarily be provisional until they are more extensively investigated.

Much arithmetical labour may be avoided in the large numbers of frequency comparisons afterwards carried out, by preparing beforehand curves of significant differences based on the various k-factors and the chosen level of significance. The level of significance adopted during the Ashdown work was $P < 0{\cdot}05$, and since all grain counts either equalled or exceeded 1,000 individuals, a frequency p_1 per cent of a mineral was considered to be significantly different from that (p_2 per cent) in another sample only when

$$p_2 > \frac{50(5p_1+k^2)+k\sqrt{2500k^2+100(k^2+500)p_1-(k^2+500)p_1^2}}{250+k^2},$$

where k was the value of k_s, k_p or k_l appropriate to the mean of p_1 and p_2. Curves were therefore prepared for the above relation as an identity (graphing p_2 against p_1) when $k = 1, 1{\cdot}5, 2, 2{\cdot}5, \ldots, 6{\cdot}5, 7$. From these, the status of a large majority of differences could be read off at sight.

The pebble counts were treated in the same general way.

Mapping of Statistics

The kinds of statistic relating to the several species, varieties, etc., obtained during the main investigation, are best plotted on to separate maps as they are obtained, and their frequency distributions finally inserted thereon. The latter may be examined by moment-analysis.

During the insertion of 'contours' designed to emphasize the main trends of change and similarity, rigid statistical control is vitally necessary if they are to have any real meaning. By far the best scheme is to make the contour intervals equivalent to minimum significant differences; for example, for $P = 0{\cdot}05$ when the total counts always exceed the intended minimum size.

When the collection of data concerning the horizon is completed, statistical reduction and analysis of variation become guides to interpretation rather than policemen to methods. The analysis and inter-horizonal comparison of correlations between variates, neatly carried out in terms of the correlation coefficient (r), is illustrative in this respect. Several significant correlations (up to $+ 0{\cdot}71 \pm 0{\cdot}087$) were established between mineral frequency and sedimentary grade size, stratigraphical variates and grade size, etc., in the Top Ashdown Pebble Bed. These in turn led to further investigations which showed, for instance in the first example, that they were usually direct results of the interplay of former hydrodynamical conditions and the relative abundance of source materials. Post-depositional alteration was shown to have taken a very minor role.

Statistical Characterization of the Sediment as a Whole

The final statistical characterization of the entire horizon is most conveniently given by the arithmetic means, standard deviations and standard errors of the frequencies, abrasion indexes, size indexes and sorting indexes of each mineral and pebble species, variety, form, etc., together with the significant correlations (qualified by their standard errors) established between certain of these variates. This should be regarded merely as a development of Butterfield's pregnant creations—his "characteristic formula" and "range formula"[3].

The problem of comparing and contrasting sediments with sediments and other rock types by means of characteristic statistics is still under investigation. Though the possibilities of using r and χ^2 appear promising in this respect[4,5], the difficulties of translating the statistical into geological correlations remain unsurmounted. Until, by their combined efforts, petrologists amass a fairly large sample of all such statistical relations, we can have no basis for making direct petrogenetical probability statements. The frequency suites of the arbitrary Ashdown horizon previously mentioned and of certain Yoredale Sandstones[3] yield (at present) $r = + 0{\cdot}89 \pm 0{\cdot}093$, but our ignorance of the geological status of this value

forbids us to conclude that it necessarily implies a close genetical relationship.

A full exposition of the statistical methods outlined above will be given elsewhere in due course.

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OBITUARY

Dr. H. D. S. Honigmann

DR. H. D. S. HONIGMANN, formerly director of the Zoological Gardens at Breslau, and recently scientific adviser to the Dudley Zoo, who died on November 17, was born at Breslau on July 5, 1891. He was educated at the Johannes-Gymnasium at Breslau, whence he proceeded to study zoology, physics and philosophy at the Universities of Breslau and Heidelberg. In 1916 he graduated at Breslau under W. Kükenthal; his thesis for his doctorate was on the primordial cranium of the hunchback whale. On his demobilization in 1918 he decided to round off his biological training by the study of medicine, and in 1921 he graduated in this subject with a thesis on parasitic flagellates of the human lung.

In 1927, after a few years of work as medical practitioner and public health officer, Honigmann was appointed director of the Zoological Gardens at Breslau. This appointment opened up for him a sphere of work which had been his ambition from early boyhood—the keeping, rearing and observation of animals. After years of war and post-war depression, it fell to him to rebuild and modernize the Breslau Zoo, a task which he performed with outstanding success. A number of scientific publications on observations on zoo animals were a by-product of this activity. He had just completed elaborate plans for a modern aquarium when his work was interrupted in 1934 by political events in Germany. He resigned his post and went to London where, following an invitation by Dr. Julian Huxley to work at the London Zoo, he carried out a series of studies on the nutrition of mammals, which led to the publication of a number of papers on the subject. His appointment in 1937 as scientific adviser to the newly founded zoo at Dudley gave him ample opportunity to make use of his wide experience in the scientific management of a modern zoo.

The outbreak of the War having brought his work at Dudley to an end, Honigmann took the post of science master at Blundell's School at Tiverton, whence the vicissitudes of the War took him to the Zoology Department of the University of Glasgow. There, on the invitation of Prof. E. Hindle and supported by a grant from the Society for the Protection of Science and Learning, he carried out a series of investigations in animal psychology, including work on the number conception in the fowl, a critical review of the problems of number conception in animals in general, and an analysis of movement vision in toads. His remarkable skill in the planning and execution of accurately controlled experiments, his thorough knowledge of the intricate problems of animal psychology, and not least his patience and experience in the handling of animals, make his publications in this field of lasting value; his last paper is still in the press and will appear in the *Proceedings of the Royal Society*. Plans for extensive further research in this field were frustrated by his death.

All who knew Dr. Honigmann will remember him as a scientific worker of great ability and experience, a warm friend and admirer of animals, and a person loved for his quiet charm, kindness and good-humoured companionship. OTTO LOWENSTEIN.

NEWS and VIEWS

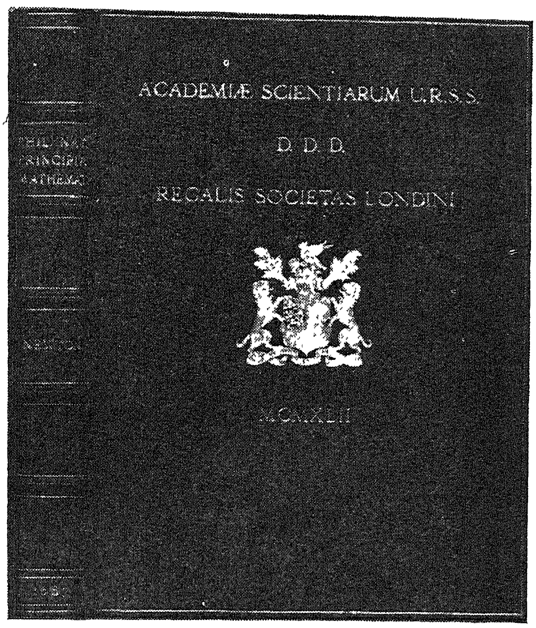
Jet-Propelled Fighter Aircraft

THE R.A.F. and the U.S. Army Air Force recently released information upon the progress made with jet propulsion for aircraft. The development of this for the R.A.F. is stated to have been in the hands of Group Captain F. Whittle, with the late Flight Lieutenant P. E. G. Sayer as test pilot. The special engine was built by Power Jets, Ltd., and the original aircraft by the Gloster Aircraft Co., Ltd. Experiments were afterwards continued in conjunction with the U.S. authorities, and further engines and aircraft were built in the United States by the General Electric Co. and the Bell Aircraft Co. respectively. These experiments have produced an aircraft judged to be sufficiently successful to warrant a partial adoption of the type, and production is now in hand of a sufficient quantity for training purposes in both countries.

The principle used in these machines is that air is taken in at the front of the body, compressed and heated, and exhausted at the rear end with increased velocity and temperature. The reaction produced is an axial thrust that replaces the normal propeller thrust. In general its efficiency would be greater, and there are additional practical advantages. The practical limitation in propeller diameter has already been reached, and some other way of turning the engine power into a propulsive thrust is necessary if any further increase in the power of individual engines is envisaged. Driving several airscrews from one engine has many practical limitations, the weight and unreliability of the transmitting mechanism being the principal, but by no means the only, trouble. Gyroscopic effects and the rotation of the slip stream are also eliminated by the absence of the rotating airscrews. Ground or water clearance can now be less if either structural or aerodynamical considerations demand it, as the propeller diameter no longer governs this. The first public claim to have produced a successful jet-propelled aircraft was made in Italy in December 1941, when it was stated that a Caproni-Campini C.C.2 machine flew from Milan to Rome at an average speed of 130 m.p.h. Speeds of this order have no application in modern war aircraft, but there is no reason why larger engines giving greater powers should not be built, when once the success of the principle is established.

Newton's "Principia" for the U.S.S.R.

On January 6 an interesting ceremony took place in Moscow. At the request of the Royal Society, H.M. Chargé d'Affaires presented to a deputation representing the Academy of Sciences of the U.S.S.R. a copy of the first edition of Newton's "Principia", together with the original draft of a letter by Newton to Prince Alexander Menshikov, acquainting the latter with his election into the fellowship of the Royal Society in 1714. The book, handsomely bound in



polished Levant morocco by the famous firm of John Gray and Sons of Cambridge, has an added value, because affixed within it is a sheet of vellum on which are recorded the signatures of the President and Council of the Royal Society in office when the gift was authorized. So far as can be ascertained, this is the only copy of a first edition of Newton's great work possessed by a scientific body in the U.S.S.R. Owing to indisposition, the President of the Academy could not be present when the gift was made; his place was, therefore, taken by the first deputy president, Academician Baykov. Incidentally, Prince Alexander Menshikov, a spectacular figure in the Russia of Peter the Great, was the first Russian to be elected into the fellowship of the Royal Society.

Prof. Vladimir A. Obruchev

The news that the honour of the Order of Lenin has recently been conferred on Prof. Vladimir A. Obruchev will be warmly welcomed by his admirers throughout the scientific world. Previously, his outstanding services to the U.S.S.R. had been recognized by his appointment as Cavalier of the Order of the Red Banner. In the minds of geographers and geologists, the names of Obruchev and Siberia are indissolubly linked. For more than a generation, Prof. Obruchev's studies of the stratigraphy, mountain-building movements and physiography of the eastern half of the vast Russian territory have earned our gratitude and respect, and his great work on the geology of Siberia (to which he has recently added a fifth volume) has become a classic. But a few decades ago, this huge region was one of the least-known areas of the globe. Prof. Obruchev's earlier expeditions and investigations of the rock succession and tectonics laid the foundations for economic developments on an astonishing scale. At an early stage of the work, he carried out the survey for the location of the Trans-Siberian railway; later, in furtherance of the far-sighted policy of the Government of the U.S.S.R., he contributed to the transformation of the country into one of the great mineral-producing regions of the earth—a story reminiscent of a fairy-tale.

Under Obruchev's inspiration, his colleagues and assistants set out to discover and exploit the mineral wealth which was to prove so essential after the German occupation of western Russia. Their activities were directed to the finding of ores of aluminium, copper, gold, iron, manganese, mercury, nickel, niobium, tin and tungsten, as well as non-metals like coal, oil and diamonds. In most cases, outstanding success crowned their efforts: in particular, the development of new goldfields owes much to Obruchev's own work. Not content with thus awakening many parts of the great area by harnessing its resources for future use, Prof. Obruchev founded in 1939 an Institute (named in his honour the Obruchev Institute) for the study of permanently frozen soil. Such soil indeed covers one third of Russian territory, so it is not surprising that the Government encouraged the Institute (in which ethnographical studies also find a place) with funds for extensive research. In 1941, when Moscow was threatened, the Academy of Sciences was evacuated to Sverdlovsk. It is satisfactory to learn that the Academy, and Prof. Obruchev, have now returned to Moscow, and that Prof. Obruchev celebrated there his eightieth birthday (on October 10 of last year).

Askanya Nova Nature Reserve

According to news reaching Great Britain, the State nature reserve at Askanya Nova, near Melitopol, in the southern Ukraine, has been completely devastated during its occupation by the German army, which evacuated the area some weeks ago. The reserve comprised a vast area of virgin steppe, where, side by side with the undisturbed flora and fauna, typical of the southern Ukrainian steppes, a large number of introduced animals and birds have been bred for years under natural conditions. A field biological station, laboratories, museum and a library were attached to the reserve, which presented unique opportunities for researches in plant and animal ecology, for experiments in the acclimatization of introduced animals and birds, etc. It is now reported that most of the animals and birds, that were living free, were killed by German hunting parties specially organized for the purpose, while the wire enclosures of others were smashed by tanks and the inhabitants killed off wholesale. Some of the more valuable animals were, however, taken away to Germany; for example, two of the three wild Mongolian horses (*Equus Przhevalskii*) were taken, the third killed. The few bisons were also killed. Most of the museum collections of birds and animals were transported to Germany, but the rich herbarium, insect collection and the library of more than 25,000 volumes were burnt. The removal of collections to Germany was carried out under the supervision of experts sent for the purpose.

Industrial Research and Taxation

THE long memorandum on "Post-war Industrial Reconstruction" issued by the Internal Combustion Engine Manufacturers' Association covers a wide field and quotes extensively from the League of Nations report on "The Transition from War to Peace Economy". While some of its proposals regarding the disposal of Government stocks of internal combustion engines after the War may be open to objection—the suggestion that the balance, after meeting the needs of devastated countries, providing a war reserve, and improving training equipment at engineering schools and technical institutions, should be disposed of by an organization, representing the industry and the Government, in the way best calculated to promote the national development and least likely to affect adversely employment in the industry, is somewhat naive—the report is yet another document emphasizing the importance of research. Dispersal of the industry's skill would undoubtedly be against the national interest, but the interests of producers can scarcely be allowed to dictate the disposal of surpluses, and the memorandum itself recognizes the necessity of continuing some national and international controls after the War, and on the whole shows a wide outlook and a readiness for more fundamental changes than mere attempts to mend the rents in the old pre-1939 patterns.

In regard to research, the memorandum urges that the position in regard to finance and especially the high level of taxation is a main reason for the inadequate prosecution of research in Great Britain. It suggests that all research expenditure should be allowed for taxation purposes, either when incurred or over a period of years, depending on the nature of the expenditure. Capital expenditure, such as that on laboratories and plant, and on patents, new designs and development to the commercial stage, should be granted relief on the basis of an allowance over a reasonable period of years. Research expenditure which is a normal incident of an efficient and progressive business should be allowed as and when made. Contributions to research organizations should be allowed similarly or, in special circumstances, spread over a reasonable period of years. Appropriate wear and tear allowances should be granted on plant and machinery acquired for the purposes of research, and if such plant and machinery is scrapped, any loss thereon, less any prior wear and tear allowance, should be allowed. The memorandum stresses the importance of clarifying the position as soon as possible, so that manufacturers can embark on an adequate programme of research and development with the knowledge that all such expenditure will rank for taxation relief.

"Political and Economic Planning"

THE Broadsheet "P E P Work, 1940–43", recently issued by Political and Economic Planning (No. 215, December 14, 1943), includes a summary of the present programme, as well as a note on some recent publications on "Research and Industry", and a complete list of P E P broadsheets and reports during 1933–43. Nine groups are in more or less regular session, and at least five full-scale reports are planned for 1944. One of these is a comprehensive report from the Fuel Group on the co-ordination of the fuel industries considered as a whole. The Population Policies Group, which is run jointly by P E P and the Eugenics Society, has begun to meet again, and it is hoped to publish a full-scale report as well as a number of broadsheets during 1944. A new edition of the P E P Report on the British Health Services is in prospect and a fully-fledged Health Group has again begun to meet regularly. The Physical Planning Group has concentrated attention in the past year on the complex social and economic factors influencing the pattern of physical planning and on the human needs to be satisfied, and in addition to further broadsheets a report will be published in 1944.

The Economic Outlook Group of P E P is conducting an investigation into the structure and functions of trade associations, and a broadsheet will be published early in the year. The International Group, from the publication of a forthcoming broadsheet on world political structure, will be replaced by an International Trade Group, the aim of which will be to present the facts about Britain's post-war export problem in its world setting. The Machinery of Government Group has completed two stages of its examination of the need for adjustment so as to make government the nation's common effective instrument for expanding its social and economic welfare, and when reconstructed this Group will tackle the problem of associating the ordinary citizen more closely with the process of local government. A special-purpose group to consider the future of Government information and publicity will follow the broadsheet on "The Future of Foreign Publicity" with one on home publicity. The work which formerly fell to the Partners in Industry Enquiry has again been taken up and several chapters drafted of a report on industrial relations, while further investigations are being made into the structure of industrial relations at the national, district and works levels.

Progress in Bacteriological Technique

PROF. J. CRUICKSHANK has prepared for the British Council an account of recent advances in bacteriological methods (*Brit. Med. Bull.*, 1, No. 8; 1943). The principal advances in the last ten years have, in his opinion, been made in the discovery of more efficient selective culture media for the isolation of bacteria, in the determination of the stable sub-groups or types of bacteria and in the development of typing methods which make it possible to trace the probable source of an infection or an epidemic. Antigenic analysis has resulted in such valuable discoveries as the Vi or virulence antigen of the typhoid bacillus. Antityphoid serum made for therapeutic use should contain Vi antibodies. The blood of typhoid carriers almost always contains these, so that the Vi agglutination test has become a valuable means of helping to trace the sources of the infection. The discovery of a Vi bacteriophage, which has a specific action on Vi strains of typhoid bacilli, can be used for the identification of particular strains of these bacilli. Epidemiologists have used this means of tracing the source of isolated infections or epidemics. The typing of diphtheria bacilli has also produced valuable results.

Work on the hæmolytic streptococci has revealed, by the extraction from these streptococci of a carbohydrate substance which gives a precipitation reaction in the presence of the appropriate anti-serum, thirteen groups of these streptococci. The streptococci of major importance in human infections belong to Group *A*, and at least twenty-three types of these have been identified. It has been found that the

same hæmolytic streptococci can give rise to various manifestations in a single community. At Queen Charlotte's Hospital in London, this typing method has provided the valuable information that, in puerperal fever, infection of the placenta by organisms in the genital passages at the beginning of labour is almost a negligible cause of puerperal fever; the important sources of infection are the attendants or other contacts, or even the upper respiratory passages of the mother herself. Similar work on the staphylococci has not yet given such striking results, but it is proceeding. The War has, of course, greatly stimulated work on organisms of the gas-gangrene group. Methods of growing anaerobic bacteria in the presence of air have been devised, and they have been grown on ordinary broth or peptone water containing a small strip of sheet iron.

A Film of Hospital Treatment

A REMARKABLE film, made by Gaumont Instructional Films, which is being shown under the auspices of the British Council, shows the successful operation by a British surgeon for the removal of the whole lung. The pictures are so taken that the spectator sees at least as much as, if not more than, most of the surgeon's assistants. At the beginning of the film the patient is shown, with his fellow workers in a factory, undergoing routine examination of the chest by X-ray. A cancer of the root of the lung is suspected in him, and the diagnosis is discussed by several experts in the light of subsequent examinations. Operation is decided upon and the patient sees the hospital almoner, who relieves his anxiety about the welfare of his wife and family while he is away from work. The special methods of anæsthetizing the patient are then shown and the operation itself follows, the spectator seeing the beating heart, the ligature and division of the pulmonary veins and the bronchus and other details. The rest of the film shows the after-care of the patient and his rehabilitation in a convalescent home until he returns to work. The British Council's chief function is, of course, to make British institutions and methods known abroad. This film, however, might well be shown widely in Great Britain.

Women's Health in War-time

IN a note entitled "Healthier Women—a War-time Asset", the *Statistical Bulletin* states that comparison of the mortality of women in the United States for the two years prior to the entry of that country into the War of 1914–18 with that for the two years (1940–41) before Pearl Harbour shows that women were benefited by the increasing control over disease. During this 25-year period, the death-rate among women insured in the Industrial Department of the Metropolitan Life Insurance Company, New York, has been reduced by about half. There were thirteen deaths in every 1,000 women aged from 15 to 74 in 1915–16 as compared with only seven in 1940–41. The decline in mortality from tuberculosis has contributed more than any other factor to this remarkable record. The control of pneumonia has also contributed much to the improvement in the total mortality among women. Diseases associated with pregnancy and childbirth have been sharply reduced since 1918. Diabetes alone has increased in the past twenty-five years among women. As regards suicide, the death-rate among insured women in 1940–41 was about two thirds the rate in 1915–16, and for accidents the proportion was three fourths.

An Ultra-High-Speed Motion-Picture Camera

ACCORDING to an article by H. J. Smith (*Bell Lab. Rec.*, 22, No. 1; October 1943) a new high-speed camera, known as the Western Electric Fastax High-Speed Motion-Picture Camera, is capable of taking pictures at the rate of 8,000 per second. Fastax cameras are made in both 8 mm. and 16 mm. models. The 8 mm. model will take from 300 to 8,000 pictures per second, depending on the voltage applied to the motors, while the 16 mm. model will take from 150 to 4,000 pictures per second. Approximately full speed is obtained at nominal line voltages from 110 to 125 volts. To secure lower speeds a rheostat may be placed in series with the motor to reduce the applied voltage.

These new cameras are of the continuous-motion type employing an optical compensator, or rotating prism, between the lens and the sprocket. The 8 mm. camera has an eight-sided prism permitting eight pictures per prism revolution, and the 16 mm. camera has a four-sided prism permitting four pictures per prism revolution; each revolves in synchronism with the film. The prism creates successive and properly spaced images travelling with the film. The image gathered by the lens is refracted by the prism upward to meet the incoming frame, and as the frame advances downward, the image follows, thereby permitting continued exposure throughout the period that the film travels past the aperture. The duration of the exposure is controlled by the speed of rotation of the prism. Both these cameras are arranged to use either 100-ft. or 50-ft. spools of film. At top speed the film travels through the camera at about 70 miles per hour, the exposure time per frame being about 1/30,000 sec. for the 8 mm. camera and 1/12,000 sec. for the 16 mm. camera. At full voltage one hundred feet of film runs through the camera in approximately 1·25 sec. The motor driving mechanism is described in the article.

Physical Significance of Maxwell's Theory

IN a lecture delivered by Mario Bunge on June 21, 1943, before the Faculty of Industrial and Agricultural Chemistry of the National University of Litoral, under the title "Significado Fisico e Historico De La Teoria De Maxwell", the work of Maxwell is considered, and its influence in his own day and also on posterity is dealt with (Buenos Aires: Universidad Obrera Argentina. Pp. 16). Among the important effects of Maxwell's theory may be noted the downfall of mechanism for the second time in history. The first non-mechanical theory was the undulatory theory of light under Huygens, Fresnel, MacCullagh, Green, Cauchy, etc., and now for the second time physics seemed to be released from the thraldom of mechanism. The opinion of Gustavo Avé Lallemant, one of the few authorities on physical science in the days of Maxwell, is worth recording. He said that the English, so practical, had created a new science, "la Electrometria", which teaches us how to calculate all the effects of electrical phenomena, though adding nothing to the manner of explaining the nature of electricity (*Anales de la Sociedad Cientifica Argentina*, **13**, 193; 1882). For Maxwell a model was simply a method for teaching but not a real need, and he was convinced that electromagnetism was not reducible to mechanism. In conclusion, it is pointed out that Maxwell's theory has developed in its form and consequences in such a manner, that in the mechanics of de Broglie, Schrödinger, Heisenberg, Born and

Dirac, not only has there been a unification in electromagnetism and optics, but these have also been unified with mechanics. The evolution of physics has therefore followed, to a considerable extent, the pathway marked out by Faraday and Maxwell.

Riboflavin Deficiency in Fowls

DEFICIENCY of riboflavin (vitamin B_2) in chick rations leads to poor growth and may give rise to 'curled toe paralysis'. Where skim milk is available, this trouble is unlikely to occur; but under war-time conditions rearers are forced to depend chiefly on mashes. Official regulations have ensured that all rearing mixtures contain adequate riboflavin; but owing to the fact that essential ingredients such as dried skim milk and dried yeast are in short supply, the possibility of using an alternative source of the vitamin has been investigated by the Chemical Division of the Agricultural Research Institute of Northern Ireland. The results are published in its sixteenth Annual Report, 1942–43. Chicks were reared from hatching to fourteen days on a basal ration adequate in protein, minerals, and vitamins A and D but deficient in riboflavin. They were then divided into groups and supplied with various levels of either dried skim milk or dried liver in addition to their basal ration, one group continuing on the basal ration alone. 5 per cent dried liver was slightly more effective than 10 per cent dried skim milk for growth, and no cases of 'curled toe paralysis' occurred in either group. So little as 1 per cent dried liver improved growth but was insufficient to prevent the leg weakness. A further test fully confirmed these results and also showed that 10 per cent dried lung was as good as 5 per cent dried liver, so that both meals may prove a valuable new source of riboflavin-rich protein supplement for chick-rearing rations. A small stock of these meals has been produced, and work on the subject is being continued.

Literature of Rheology

IN the August issue of the *Rheology Bulletin*, published by the Society of Rheology under the auspices of the American Institute of Physics, a new feature, "Rheology Reviews", is started with a survey by Dr. R. Dow of "Some Rheological Properties of Matter under High Hydrostatic Pressure". It is intended that the new series shall furnish a perspective of a wide field of knowledge, and that each survey shall be prepared by an expert in the field. In the same number more than twenty pages of abstracts are given. The journal is published quarterly from 175 Fifth Avenue, New York, N.Y., and was founded to help workers in the fields of elasticity, viscosity, plasticity and the like, to a better understanding of their common problems. It was created as a medium for the exchange of information as to theories and methods relating to the rheological properties of matter. The issue for November 1942 contains details of the contents of the *Journal of Rheology* published by the Society during 1929–33. In 1933 the new journal *Physics*, now called the *Journal of Applied Physics*, began to publish the rheological material. Incidentally, the *Bulletin* illustrates a cheaper method of publication of journals with a small circulation: the matter is prepared on a typewriter with graphs and the mathematical parts added by hand. The copies are then printed by the use of photo-lithography.

Electrolytic Production of Hydrogen and Oxygen

"The Production of Hydrogen and Oxygen by the Electrolysis of Water" is the subject of a paper (*J. Inst. Elec. Eng.*, 90, Pt. 1, No. 35; Nov. 1943) by Mr. C. E. Bowen, which reviews the principles and practice of the electrolysis of water and discusses its interest to the electrical engineer. Following the chemical expression of the process, the various factors influencing the yields and power requirements are considered. In the theoretical treatment, the application of Faraday's law is discussed, together with the question of current efficiency. The factors controlling the cell voltage, such as minimum-decomposition voltage, over-voltage, current density and resistance of electrolytes are studied, data being supplied as a guide to the general design requirements of this type of equipment. Methods and materials of construction are also discussed, with some notes on the handling of the gases. The paper describes some modern types of apparatus, and the performance of the equipment is illustrated. The demand for the two gases is discussed and some of their uses are defined. Finally, the author suggests, on the basis of some of the figures included, that the large amounts of power concerned should be of the greatest interest to electrical engineers.

Anti-malaria Campaign in Panama

A RECENT paper (*Bol. Of. San. Panamericana*, 22, 502; 1943) published by the Malaria Section of the Ministry of Public Health and Public Works of Panama contains an account of the following means adopted against malaria in Panama. More than 300 Anopheles breeding places in the towns of the interior are regularly kept under control by weekly inspection and identification of the larvæ. Eight species of Anopheles have been identified, namely, *A. albimanus, argyritarsis, pseudopunctipennis, apicimacula, albitarsis, strodei* and *neomaculipalpus*. The methods most favoured include the use of oil and Paris green. Paris green, which destroys only the larvæ, is preferred owing to the economy in use and facility of transportation. An approximate idea of the incidence of malaria in the different regions can be obtained from the incidence of malaria mosquitoes and the splenic enlargement and parasitic determination in school children. Rainfall records in infested regions are also of help. Sanitary education by lectures, cinemas, meetings, etc., is slowly progressing.

Treatment of Peripheral Nerve Injuries

THE *British Medical Bulletin* is published monthly by the British Council for distribution abroad. Each number contains, in addition to valuable summaries of British research papers of medical interest, a special summary of recent work in some field of inquiry, which is written by an authority on that subject. Prof. H. J. Seddon, in an issue devoted to peripheral nerves, writes upon peripheral nerve injuries (*Brit. Med. Bull.*, 1, No. 7; 1943). Clinical problems presented by nerve injuries have not, he says, received great attention except during times of war, when injuries of peripheral nerves are commoner than they are in normal times. The increasing mechanization of our civilization may, however, result in an increase of peripheral nerve injuries even in times of peace. In 1940 the Ministry of Health and the Medical Research Council established, at civilian hospitals in the Emergency Medical Service,

five centres for the treatment of nerve injuries, three in England and two in Scotland. Similar centres have been organized in Natal, India and the Middle East. Treatment often extends over long periods and rehabilitation is both general and specific, the former being designed to keep men fit mentally and physically and the latter to encourage fine co-ordinated movements and the recovery of tactile discrimination. It is often possible for a man to return to work or to military service before recovery is complete. R.A.F. pilots are even able to return to operational flying before they have completely recovered. While complete restoration of function occurs in only a minority of cases, it is remarkable how many patients are able either to return to their former work or to train for new jobs.

Research is also carried out at these beneficent centres. It provides a check on the efficacy of the treatment given and a clearer definition of the various types of injury. Much information is obtained by special methods of examination which could not be obtained in any other way. Animal experiments are also used, and Prof. Seddon thinks that only the balanced combination of this and clinical observation can provide steady progress. The help of the modern highly-trained veterinarian might well be enlisted here. Between three and four thousand cases have already been treated at these centres and, as Prof. Seddon says, the mass of information which is being obtained should greatly advance this branch of neurology.

Emergency Lighting Systems

A PAPER on the applications of emergency lighting systems with particular reference to battery equipments was read before the Institution of Electrical Engineers in London on November 11 by Mr. S. H. Chase, who pointed out that in recent years there has been an increasing call for the installation of emergency lighting systems. These can be provided by candles or nightlights, gas, dry- or wet-battery torches, accumulators, engine-generator sets, alternative independent mains supply, or by a combination of several methods. The amount of emergency lighting may range from an intensity equal to normal down to the minimum considered necessary for safety and continuation of essential services. The paper deals mainly with the use of accumulators for standby purposes, operated either manually or automatically upon failure of the mains supply, and capable of supplying loads for varying periods according to the class of installations, which are grouped under five heads: theatres and cinemas, hospitals and nursing homes, public buildings, etc., factories and A.R.P. services.

Modern Insulating Materials

IN a paper on "The Control, Specialized Testing and Use of Some Modern Insulating Materials", Mr. A. R. Dunton (*J. Inst. Elec. Eng.*, 90, Pt. 1, No. 35; Nov. 1943) deals briefly with the details associated with the control of incoming materials to the factory, together with some special features associated with tests which have to be carried out in order that the performance of the materials under special conditions can be ascertained. To achieve this work, special testing apparatus has been designed from time to time, and brief reference is made to some of the problems which have to be solved in order to ensure that the insulating materials selected will fulfil the performances required. Suggestions are also made dealing with the question of finding substitutes for insulating materials in short supply, and some of the new materials introduced for this purpose are mentioned.

Announcements

DR. R. E. PRIESTLEY, vice-chancellor of the University of Birmingham, has been appointed an additional member of the Commission on Higher Education in the Colonies. The appointment has been made in consideration of the fact that Prof. A. V. Hill's absence in India makes it impossible for him to take part in the proceedings of the Commission for some time.

DR. H. W. THOMPSON, lecturer in chemistry in the University of Oxford, will deliver the Tilden Lecture of the Chemical Society on January 20 at 2.30 p.m.; he will speak on "The Scope and Limitations of Infra-Red Measurements in Chemistry".

THE trustees of the Miners' Welfare National Scholarship Scheme, established by the Miners' Welfare Commission for the provision of university scholarships for workers in or about coal mines and their sons and daughters, have appointed Principal J. F. Rees, of the University College of South Wales and Monmouthshire, Cardiff, to be a member of the selection committee to recommend awards under the scheme, in succession to Prof. J. F. Duff, who has retired after completing five years on the committee.

THE Therapeutic Corporation of Great Britain has elected the following officers for the year 1944: *Chairman, Board of Directors:* Mr. H. Jephcott (Glaxo Laboratories, Ltd.), (succeeds Dr. T. B. Maxwell, May and Baker, Ltd.); *Deputy Chairman, Board of Directors:* Dr. F. H. Carr (The British Drug Houses, Ltd.), (succeeds Mr. H. Jephcott, Glaxo Laboratories, Ltd.); *Chairman, Research Panel:* Dr. A. J. Ewins (May and Baker, Ltd.), (succeeds Dr. F. L. Pyman, Boots Pure Drug Co., Ltd.); *Deputy Chairman, Research Panel:* Mr. F. A. Robinson (Glaxo Laboratories, Ltd.), (succeeds Dr. J. W. Trevan, The Wellcome Foundation, Ltd.). The Corporation has appointed Dr. Frank Hartley as secretary, to take up duties early in 1944. The new offices of the Corporation are at General Buildings, 99 Aldwych, W.C.2.

A COURSE of twelve lectures on "The Psychology of Frustration and Fulfilment in Adolescence" has been arranged by the National Council for Mental Hygiene. They are being delivered in the Caxton Hall, London, S.W.1, on Tuesdays, beginning January 18, at 5.15 p.m. The lectures are specially addressed to those with social and educational interests. Dr. J. A. Hadfield will speak on the psychology of adolescence; Dr. Paula Heimann on the psychoanalytic approach; Mr. R. W. Moore, headmaster of Harrow School, and Mr. T. F. Coade, headmaster of Bryanston School, will discuss the teacher's approach to the problems of the adolescent boy; Miss L. V. Southwell, headmistress of St. George's School in Switzerland, will deal with the adolescent girl in boarding schools; and Miss Olive Willis, headmistress of Downe House, Newbury, will discuss the teacher's approach to the problems of the adolescent girl. Tickets (single lectures, 3*s.* 6*d.*; course, £1 10*s.*) can be obtained from the Secretary, National Council for Mental Hygiene, 39 Queen Anne Street, London, W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Adsorption as the Cause of the Phenomenon of the 'Floating Drop', and Foam consisting solely of Liquids

DROPS of a liquid may be floating on the surface of the same liquid before coalescence occurs. This 'phenomenon of the floating drop', as it may be called, was apparently first described by O. Reynolds in 1881. It was investigated by E. Kaiser (1894) and explained as due to the presence of an air layer between the drop and the surface of the bulk liquid. L. D. Mahajan, in numerous papers (1929–34), studied the phenomenon, concluding that it was due to a 'cushion' of air or other surrounding medium (kerosene or olive oil); the more viscous this medium, the more stable are the drops. F. H. Hazlehurst and H. A. Neville[1] extended the study to drops floating on a surface of another liquid. They rejected the previous interpretations, and assumed "that the surface of any liquid is quasi-solid, being composed of crystallites".

Having given a good deal of attention to this phenomenon—primarily without knowledge of the previous work—we have been led to the general view that *the phenomenon of the floating drop is caused by the adsorption of a foreign substance at the surface of the liquid*; the greater the viscosity appearing at the surface, the higher is the stability of the phenomenon.

Some observations supporting this view may now be given. Ethanol, considered earlier to be one of the most effective liquids in showing the phenomenon, was found to give floating drops lasting about 8·0 sec. in ordinary air (Fig. 1). In dry air the life-time of the drops was only 0·7 sec. Hence, in ethanol, the phenomenon is essentially due to the adsorption of moisture from the air. In an evacuated apparatus the phenomenon disappears entirely. Hence, the (less marked) phenomenon still appearing in dry air must be caused by the adsorption of air. This was further supported by the fact that a thin (0·4 mm.) ethanol jet in air, when so long (more than 30 mm.) that no floating drops appeared, gave rise to numerous air bubbles in the bulk liquid; when the length was less than 30 mm., with a lot of floating drops appearing, the air bubbles ceased to appear.

In saponin solutions the life-time (τ) of the drops was found to be a function of the concentration (Fig. 2, I), with a maximum at 1 per cent. This is quite similar to that of known adsorption isotherms. If, immediately before the timing observations, a series of rapid droppings was made, the stability of the drops considerably increased (series II). This must be ascribed to an accumulation on the flat surface of saponin adsorbed on the drops, and evidence of the importance of adsorption.

Fig. 1.

Our observations emphasize the analogy between the phenomenon of floating drops and the formation of bubbles or foam. As a matter of fact, pure liquids are known not to foam; the main factor is adsorption, exerted by a capillary active substance; a high stability presupposes a certain viscosity of the adsorbed layer.

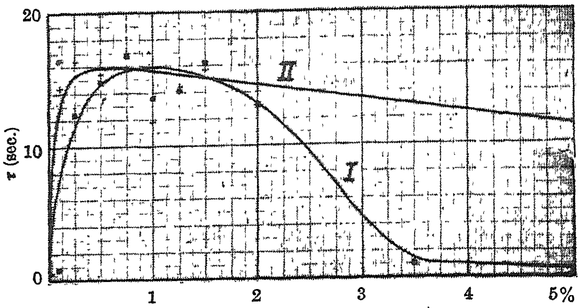
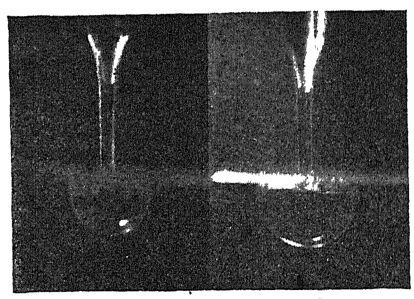


Fig. 2.

Saponin solutions, as is well known, form in air a rather stable foam. We observed that foam is formed by a saponin solution kept in an evacuated vessel, but the stability of this foam was found to be much lower than in air. Hence, we may conclude that foam, under ordinary conditions, is partly stabilized by an adsorbed layer of air.

In a similar way, the considerable stability of floating saponin drops must partly be due to adsorbed air: in an evacuated vessel, saponin solutions—under the conditions used—actually gave no floating drops.

Fresh malt beverage was found to give persistent floating drops (up to 28·6 sec.). When the carbon dioxide had been removed *in vacuo*, however, the life-time was only 0·2 sec. This is parallel to the fact that the foaming ceases when carbon dioxide is removed. Hence the adsorption of carbon dioxide in both cases exerts a considerable influence.



a b

Fig. 3.

Saponin solutions were found to give persistent floating drops not only in air but also in nitrogen and in oxygen as well; the stability was greater in nitrogen.

The explanation given by Kaiser and by Mahajan, implying that the phenomenon is caused by a thin foreign layer, obviously is in good harmony with our statement of the influence of adsorption. As for the assumption of Hazlehurst and Neville—implying that the 'foreign' layer would be composed of crystallites of the pure liquid itself—this appears now unnecessary and is scarcely in harmony with the fact that the phenomenon does not occur *in vacuo*.

With saponin solution, it was found possible to form rather large floating drops (11 mm. in diameter) by successively dropping on single drops. The foreign 'adsorbed' layer necessary may also be realized by using a thin layer of oil, spread on a water surface. When dropping on water, very large floating drops may be produced, as evidenced in Fig. 3, showing drops formed by the coalescence: in *a* of 30 single drops, in *b* of about 80 drops (diameter 16 mm.). These fairly stable spherically limited masses of water in water with an extremely thin oil layer remind one of the spherical oil masses in alcohol of the same density produced by Plateau.

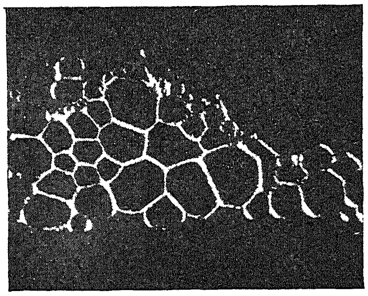


Fig. 4.

We were further led to the production of a foam, consisting solely of liquids. Such a 'liquid-foam' is evidenced by Fig. 4. The cell walls are saponin solution (0·5 per cent), the cell content is oil ('Lighthouse', Pratt), which has been introduced into the saponin solution—kept at the bottom of a thin cuvette.

The appearance of the fluid-foam was very similar to the 'gas-foam' formed in the same cuvette on introducing air into the saponin solution.

The main interest of the fluid-foam is that it affords a rather close analogy with the capillary grain structure of solid metals[2].

A detailed account of this work will appear in *Arkiv för Matematik, Astronomi och Fysik*, vol. 30 A, of the Royal Swedish Academy of Sciences, Stockholm.

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PER SEDERHOLM.

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Stockholm.

[1] Hazlehurst and Neville, *J. Phys. Chem*, 41, 1205 (1937).
[2] Cf. Benedicks, 18e. Congrès de Chimie Indust. (Nancy, 1938). *Chimie et Industrie* (Paris, 1939). *Koll. Z.*, 91, 217 (1940).

Interpretation of Patterson Diagrams

PROF. J. MONTEATH ROBERTSON's communication on the above subject in NATURE[1] suggests a modified method, based on the same geometrical principle.

I refer now to the diagram in Prof. Robertson's communication. Let AA' and BB' be opaque screens pierced in the points 1, 2, . . . and 1', 2', . . . respectively. If AA' is illuminated from the left, the peaks in the Patterson diagram will appear on the surface CC'.

The two screens AA' and BB' can be rapidly prepared by punching circular holes in sheets of cardboard. The holes form the pattern of the projected atomic positions and the pattern on AA' may be drawn to a scale twice as large as that of the pattern on BB'. In this case the distance from AA' to BB' should be equal to the distance from BB' to CC'. The unit area will then be the same on AA' as on CC'. The integrated intensity of a projected Patterson peak will be proportional to the product of the areas of the two corresponding holes. If the distances between the screens are large compared with the extension of the atomic patterns, and if the holes in AA' and BB' are made to correspond to atomic contours, the contours of the Patterson peaks will be practically circular and the diameter of a circle will be the sum of the diameters of the two corresponding atom holes in AA'. Important features of the real Patterson function are thus rather closely attained.

The projection surface CC' is preferably a ground-glass plate, which is viewed from the right. The contours of the real Patterson diagram can be drawn on the ground-glass surface, thus enabling an easy comparison with the projected picture.

Compared with Prof. Robertson's method, the modified method outlined here lacks the possibility of continuous variation. However, the variation can be carried out quite rapidly, and the modified method seems to possess certain advantages in other respects.

G. HÄGG.

Chemical Institute of the University,
Uppsala.
Nov. 3.

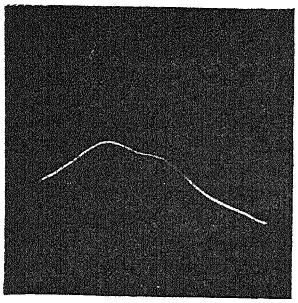
[1] NATURE, 152, 411 (1943).

A New Type of Microphotometer

UNDER this title[1] R. Fürth gave a short description of an instrument designed for providing a practically instantaneous record on a cathode ray oscillograph of the density distribution along a short straight line on a photographic plate. This record was in fact obtained by the superposition of two traces writing in opposite directions on the screen of the cathode ray oscillograph, corresponding to the two directions of the vibrational motion of the plate through the slit image. A rather thick curve resulted, therefore, with loss in detail compared with the records of other existing types of microphotometers. In addition, fluctuations in frequency of the mains voltage by which the instrument is operated could cause slight displacements of the two traces[2].

A brief description is given here of an improvement on Fürth's microphotometer which has resulted in an increased resolving power and more satisfactory working conditions. It consists in the application between grid and cathode of the cathode ray tube of a periodic 'square wave' voltage which controls the brightness of the fluorescent spot on the screen in such a way as to make only one trace visible. To produce this voltage (which must be properly related to the time-base voltage) an electrical circuit is used which is comprised mainly of a 90° phase-shifting network with an amplifier the output of which is applied to a peak-clipping device.

In order to demonstrate the improved performance of the instrument, three photographic records are shown relating to the density distribution in a photograph of the arc spectrum of copper in the neighbourhood of 3440 A., taken with an ordinary glass spectrograph. Records 2 and 3 (with original magnification of 30) each cover a range of 15 A. approximately. Record 1 is of the central hump in record 2; it corresponds to an original magnification of 200 and covers a range of 2·2 A., and a distance of 0·24 mm.



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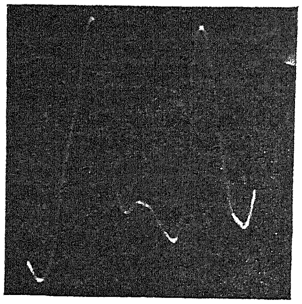

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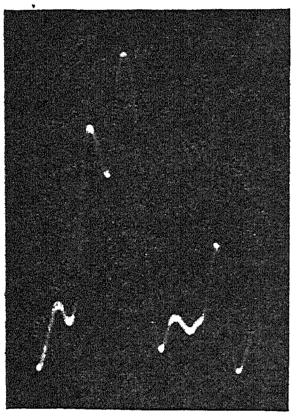

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on the spectrum photograph. On the oscillograph screen a distance of 1 mm. corresponded to 0·3 A. in records 2 and 3 and to 0·045 A. in record 1.

These curves, in addition to giving evidence of the increased resolving power now available with the aid of this device (as will be seen by comparison with the first note on the microphotometer quoted above), serve to illustrate how the magnification of the instrument can be altered at will to study more closely any portion of the photometric curve.

A more detailed description of the device will be published elsewhere shortly.

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University,
Edinburgh.

[1] Fürth, R., NATURE, 149, 730 (1942).
[2] Fürth, R., *Proc. Phys. Soc. London*, 55, 34 (1943).

Meiosis of a Triple Species Hybrid in Gossypium

SKOVSTED[1,2] brought forward considerable cytological evidence that New World ($n = 26$) cottons originated by amphidiploidy from crosses between ancestral Asiatic ($n = 13$) and American ($n = 13$) parents. Recently Harland[3] and Beasley[4] have independently synthesized by colchicine treatment amphidiploids from hybrids between present-day Asiatic and American diploid species. Since the synthesized amphidiploids produce partly fertile hybrids on crossing with present-day New World types, they contribute strong supporting evidence to Skovsted's theory. It should be pointed out, however, that such evidence can only be considered critical if it can be shown that genom combinations *other* than Asiatic + American do not pair equally well with the New World complement. I have brought forward[5,6] phenogenetic evidence which suggests that critical examination of Skovsted's hypothesis may now be confined to testing combinations between Asiatic species and one or other of several entire-leaved species. The following combinations should be worth testing:

(1)	Asiatic (A)*	+	*G. aridum*	(D)
(2)	Asiatic (A)	+	*G. klotzschianum*	(D)
(3)	Asiatic (A)	+	*G. raimondii*	(D)
(4)	Asiatic (A)	+	*G. sturtii*	(C)

* Letters indicate genoms according to Beasley's system.

It will be noted that all combinations except the fourth include an American diploid genom. Clearly if *G. sturtii* could be eliminated as a possible ancestor of New World cottons, Skovsted's hypothesis would be considerably strengthened. The low meiotic pairing found by Skovsted[2] in New World × *G. sturtii* hybrids (A C D) and the high pairing found by Beasley[7] in the corresponding hexaploid $(A\ C\ D)_2$ certainly do not suggest *G. sturtii* as a possible parent—a conclusion which is supported by the data presented below.

A triploid (A A C) was recently obtained by crossing an autotetraploid Asiatic cotton with *G. sturtii*. The meiotic behaviour of this hybrid has been fully reported elsewhere[8], when it was shown that homology between A and C genoms was very low. The triploid was treated with colchicine, and pollen from some of the distorted flowers produced during the ensuing abnormal vegetative growth appeared to be viable. New World species were accordingly crossed persistently with pollen from these flowers. A completely sterile hybrid with 52 chromosomes was eventually obtained from 103 attempted crosses. Since it is known that the New World female parent (*G. barbadense*) produced normal 26 chromosome gametes, the gametes from the male parent must also have contributed 26 chromosomes. Furthermore, since the hybrid had the distinctive mauve petal colour of *G. sturtii* and plant hairiness characteristic of the Asiatic type used—neither of which characters was carried by the *barbadense* parent—it was certain that both Asiatic and *sturtii* chromosomes had been included. With the knowledge that unbalanced gametes are very rare in Gossypium, and that *sturtii* and Asiatic chromosomes have low homologies, it seems likely that complete A and C genoms were contributed by the male parent. If this is accepted provisionally, the hybrid should have the following constitution:

$$♀ \rightarrow AD/AC \leftarrow ♂.$$

At meiosis the A genoms should pair as bivalents or higher associations, as shown by Skovsted's[1] Asiatic × New World hybrids, while the C and D genoms, if their pairing is similar to that found in Skovsted's[2,9] American diploid × *G. sturtii* hybrids, should show low and very variable pairing. Univalents should consist of two types—very large from the C set and small from the D set.

Meiotic studies of the hybrid agree reasonably well with expectation:

Cross	Average number of univalents per PMC	No. of PMC's examined	
Triple hybrid..........	11·8 ± 0·8	20	
Davidsonii × *sturtii*	15·0 ± 0·8	40	Skovsted's data
Sturtii × *armourianum*	8·5 ± 0·9	20	

Owing to the uniformly high variability, the number of univalents found in each hybrid barely differs significantly. A typical first metaphase plate of the triple hybrid is shown in Fig. 1. The great range in size of the univalents is apparent (see also Fig. 2), although I do not consider it possible to classify them *all* with certainty as C or D types. However, the evidence as it stands is sufficient to demonstrate, under identical cytological conditions, the low homologies existing between Asiatic, New

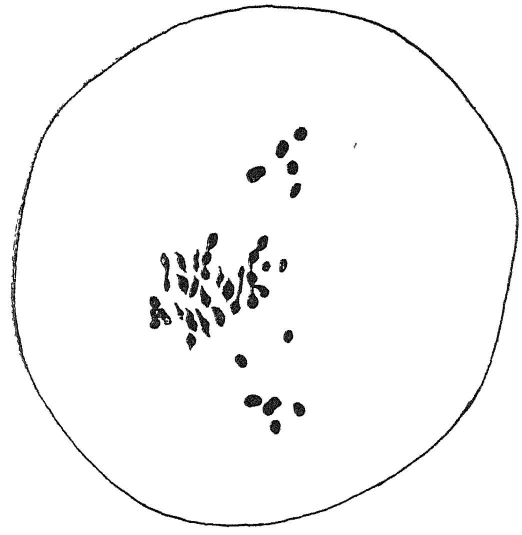

Fig. 1. METAPHASE I IN THE TRIPLE SPECIES HYBRID, *G. barbadense* × *G. arboreum* × *G. sturtii* (*A C D*) SHOWING 1 V, 2 IIIs, 14 IIs AND 13 Is. (× 1200).

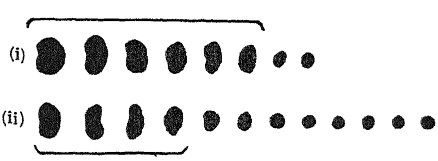

Fig. 2. UNIVALENTS FROM TWO OTHER METAPHASE I PLATES. PROBABLE *C* UNIVALENTS ARE BRACKETED. (× 1,800).

World, and *sturtii* genoms, and hence *G. sturtii* may be dismissed as a possible parent in the origin of New World cottons.

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[2] Skovsted, A., *J. Genet.*, **34**, 97 (1937).
[3] Harland, S. C., *Trop. Agric.*, **17**, 53 (1940)
[4] Beasley, J. O., *Amer. Nat.*, **74**, 285 (1940).
[5] Stephens, S. G., *J. Genet.* (in the press).
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[7] Beasley, J. O , *Genetics*, **27**, 25 (1942).
[8] Stephens, S. G., *J. Genet.*, **44**, 272 (1942).
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Development of Gametocytes from Extra-erythrocytic Forms in *Plasmodium gallinaceum*

IT was shown in a previous paper[1] that if fowls inoculated with emulsions of organs containing extra-erythrocytic forms of *Plasmodium gallinaceum* are subjected to intense and continuous quinine treatment (150 gm./kgm. body weight quinine hydrochloride daily), they eventually become heavily infected with extra-erythrocytic forms in the complete absence of erythrocytic schizogony. During quinine treatment the red cells become infected with small non-pigmented parasites derived directly from extra-erythrocytic forms. These small non-pigmented forms do not develop further unless the quinine is stopped or the dose diminished, in which case they undergo the normal cycle of development in red cells. The same results are obtained in birds subjected to the bites of infected mosquitoes, *Ædes ægypti*, and to continued intensive quinine treatment. With the interruption of quinine treatment the parasites in the red cells, all derived from extra-erythrocytic forms, undergo normal development which can be readily followed by examining the blood at various intervals.

Discussing these findings with us, Brigadier J. A. Sinton asked whether or not gametocytes are derived from extra-erythrocytic forms.

Experiments on birds infected by the bites of *A. ægypti*, and subjected to intense quinine treatment which was stopped only after red cells were infested with small non-pigmented parasites, showed beyond all possible doubt that among the merozoites produced by extra-erythrocytic forms some invade red cells and develop directly into gametocytes. Young gametocytes can be recognized $27\frac{1}{2}$ hr. after the cessation of quinine, and they approach their maximum size before the first cycle of erythrocytic schizogony is completed.

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[1] Adler, S., and Tchernomoretz, I., *Ann. Trop. Med. and Parasit.*, **35**, 271 (1941).

Effect of *p*-Amino-Benzoic Acid on the Toxicity of *p*-Amino-Benzene-Sulphonamide to Higher Plants and Fungi

MOST of the published observations on the antagonism between *p*-amino-benzoic acid and *p*-amino-benzene-sulphonamide relate to the growth of bacteria, but work carried out in these laboratories and elsewhere shows that this antagonism also obtains with higher plants and fungi.

Working with isolated tomato roots growing in tissue culture, Bonner[1] has described a growth inhibition caused by *p*-amino-benzene-sulphonamide which is reversed in the presence of *p*-amino-benzoic acid. More recently I have observed a similar response from complete plants growing under more natural conditions. In a series of experiments connected with the control of seed-borne fungoid diseases of wheat, the following observation was made. *p*-Amino-benzene-sulphonamide in fine powder form was applied to wheat at the rate of 0·01 per cent, and the grains were sown in soil. The emergence was markedly reduced, and those plantlets which did emerge were stunted. If the grains are soaked in aqueous solutions of *p*-amino-benzene-sulphonamide and are subsequently sown in moist sand at 22° C., percentage germination after five days is not affected, but the coleoptile and roots are stunted. Addition of *p*-amino-benzoic acid to the aqueous solution of *p*-amino-benzene-sulphonamide cancels this stunting effect, as is shown by the series of experiments recorded in Tables 1 and 2.

TABLE 1 MEAN PERCENTAGE GERMINATION OF WHEAT SEEDS: FIVE DAYS AT 22° C.

Concentration of *p*-amino-benzene-sulphonamide solution	Concentration of *p*-amino-benzoic acid			
	Nil	0·1 p.c.	0·25 p.c.	0·5 p.c.
Nil	100·0	100·0	100·0	100·0
0·5 per cent	100·0	97·3	98·6	100·0
1·0 per cent	100·0	98·6	100·0	96·0

TABLE 2. MEAN COLEOPTILE LENGTH (mm.) OF WHEAT SEEDLINGS.

Concentration of p-amino-benzene-sulphonamide solution	Concentration of p-amino-benzoic acid			
	Nil	0·1 p.c.	0·25 p.c.	0·5 p.c.
Nil	50·8	46·5	50·0	41·6
0·5 per cent	7·4	9·4	26·3	38·6
1·0 per cent	7·3	7·9	20·4	35·3

This result naturally led to the extension of the work to cover fungi as well as higher plants, but here it was found from the literature that Dimond[2] had already observed that *p*-amino-benzene-sulphonamide had a retarding effect on the dermatophytic fungus *Trichophyton gypseum*, which is antagonized by *p*-amino-benzoic acid. However, I have found that *p*-amino-benzene-sulphonamide has also a delaying effect on the early stages of germination and growth of the fungi *Penicillium digitatum* Sacc., *Fusarium caeruleum* (Lib.) Sacc. and *Botrytis Allii* Munn. This initial delaying effect is eliminated by very small concentrations of *p*-amino-benzoic acid. Various concentrations of *p*-amino-benzene-sulphonamide and *p*-amino-benzoic acid were included in a synthetic agar medium (Raulin-Thom) in Petri dishes. The surface was spread with a spore suspension, the plates incubated at 25° C., and the amount of growth recorded at intervals in arbitrary units. Addition of *p*-amino-benzoic acid alone in no way affected the growth of the fungi. Results of a typical experiment are shown in Table 3.

TABLE 3. EFFECTS OF *p*-AMINO-BENZOIC ACID AND *p*-AMINO-BENZENE-SULPHONAMIDE ON GROWTH OF *Penicillium digitatum*.

Concentration of p-amino-benzene-sulphonamide in medium (p.p.m.)	Concentration of p-amino-benzoic acid in medium (p.p.m.)					
	At 3 days incubation			At 7 days incubation		
	Nil	10	100	Nil	10	100
Nil	++	++	++	++	++	++
12·5	+	++	++	++	++	++
25	—	++	++	++	++	++
50	—	++	++	++	++	++
100	—	++	++	++	++	++

— no growth.
\+ reduced growth.
++ normal growth.

The generally accepted explanation of the antagonism between *p*-amino-benzoic acid and *p*-amino-benzene-sulphonamide, developed by Woods[3] and Fildes[4], is that *p*-amino-benzene-sulphonamide inactivates bacteria by virtue of a competitive inhibition of an enzyme reaction involving the utilization of *p*-amino-benzoic acid. From the results with higher plants and fungi now reported, it would appear, if the hypothesis of Woods and Fildes is accepted, that the enzyme reaction concerned is common to several widely distinct types of living organism. This suggests that it may eventually be found to be associated with some metabolic process of fundamental importance to living matter.

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[1] Bonner, J., *Proc. U.S. Nat. Acad. Sci.*, **28**, 321 (1942).
[2] Dimond, N. S., *Science*, **94**, 420 (1941).
[3] Woods, D. D., *Brit. J. Exp. Path.*, **21**, 74 (1940).
[4] Fildes, P., *Lancet*, **1**, 955 (1940).

Mathematics of Biological Assay

IN a recent paper on "The Technique of the Biological Vitamin A Assay"[1], N. T. Gridgeman describes a method in which four equivalent groups of animals are given respectively doses D_s and nD_s of a standard preparation of known vitamin A content, and doses D_t and nD_t of the material under test. From their growth responses, G_s, G_{ns}, G_t, G_{nt}, the dose ratio D_t/D_s in terms of vitamin potency is calculated. Gridgeman assumes that the true relationship between growth G and dose D is of the form :

$$G = a + b.\log D + c.(\log D)^2, \quad . \quad . \quad . \quad . \qquad (1)$$

but employs a method of calculation in which the last term is ignored, that is, the relationship between G and $\log D$ is taken as linear. The slope b is calculated separately from the 'standard' growths and the 'test' growths, and the mean of the two values (which may differ significantly) is used to estimate D_t/D_s, again as the mean of the two possible values (see below). He shows for a typical set of figures that the result obtained does not differ, within the accuracy of the arithmetic, from the true value, and concludes : "This compensatory effect operates over fairly wide limits : it certainly covers all curves in our experience. An incidental inference is that a statistical demonstration of departure from parallelism in a biological assay is not necessarily evidence of the invalidity of the test".

I was led by these remarks to go further into the mathematics of the problem. Suppose that in the most general case the relationship between G and D is :

$$G = a + b.\log D + c.(\log D)^2 + d.(\log D)^3 + \text{etc.} \qquad (2)$$

Assume also that in a particular assay the *true* value of the ratio D_t/D_s is q. Following Gridgeman's method of evaluating this ratio, b is estimated as the mean of $(G_{nt}-G_t)/\log n$ and $(G_{ns}-G_s)/\log n$, that is, $(G_{nt}+G_{ns}-G_t-G_s)/2 \log n$. Denote this by b_e. The two available estimates of D_t/D_s, namely, antilog $(G_t-G_s)/b_e$ and antilog $(G_{nt}-G_{ns})/b_e$ are averaged for the final estimate, which is thus obtained from the equation :

$$\log \frac{D_t}{D_s} = \log n \left(\frac{G_{nt} + G_t - G_{ns} - G_s}{G_{nt} - G_t + G_{ns} - G_s}\right) \quad . \quad . \quad (3)$$

Now express the various G's as functions of the corresponding D's from equation (2) ; replace $\log n.D_t$ by $(\log n + \log q + \log D_s)$, and similarly for $\log D_t$, $\log n.D_s$; and expand second degree and higher terms where necessary. The resulting algebra is tediously lengthy, but many of the simpler terms cancel out, and the bracketed part of (3) reduces to :

$$\frac{\log q(2x + y_1)}{\log n(2x + y_2)}, \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \qquad (4)$$

where $x = b + c(\log q + \log n + 2 \log D)$, and y_1, y_2, are multinomials the coefficients of which are d and higher coefficients from (2).

Now over at least that part of the $(G, \log D)$ curve which is used in practice, and remembering the error inherent in biological assays, Gridgeman is perfectly justified in assuming the truth of equation (1), that is, in neglecting third and higher powers of $\log D$ in (3). This is equivalent to putting $y_1 = y_2 = 0$ in (4), and (3) then becomes :

$$\log \frac{D_T}{D_s} = \log n \left(\frac{\log q \times 2x}{\log n \times 2x}\right) = \log q, \text{ the true value.}$$

In other words, Gridgeman's method of calculation leads to a correct result, not because of a "compensatory effect" between "fairly wide limits", but because of a mathematical identity which is exact so long as equation (1) is true. Moreover, from a mathematical aspect, the intraclass dose ratio n and the interclass dose ratio q may both vary widely without affecting the validity of the calculations (though practical considerations may impose a restriction). Thus, Gridgeman's method is both of more general application and of greater mathematical rigidity than he supposes, and deserves the attention of all workers in this field.

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[1] *Biochem. J.*, **37**, 127 (1943).

Relation between Dissonance and Context

In view of the discussion with Mr. C. G. Gray[1] about the effect of context on dissonance, it may be useful to publish, with permission of the authors of the respective letters, certain criticisms which have been sent privately.

Prof. Cyril Burt is sympathetic with the hypothesis "that the dissonant character of a chord depends upon its context", but he wishes "to learn whether the musical experience and proclivities of the subjects made any difference to their reports". He himself attempted to test Helmholtz's theory of harmony "by means of correlating orders of dissonance and orders of pleasantness", and found that "the lack of correlation differed according to the musical experience of the examinees. Nearly everybody would rank the pleasantness of a major third far too high for the effect to be explained by absence of beats; but a few modern people would rank a tritone quite near the top. In fact, it seemed clear that, in ranking chords for their pleasantness, a large number of examinees were ranking them for their 'interesting' character. Thus an open fifth, though, according to Helmholtz's principles it should make a very good consonance, would be put near the bottom because it was devoid of interest". "Here again," he writes, "context makes all the difference. Beethoven's open fifth at the beginning of the Ninth Symphony actually heightens one's interest and curiosity just because of its non-committal character. In fact, here it almost seems to act like a dissonance. One seems to want a resolution in the sense of a major or minor third, so that one can at last feel assured what the actual key is going to be."

Dr. H. Banister is concerned about the effect of the equal temperament of the modern piano upon the character of chords, and thinks that it is not possible to assume, as Gardner and Pickford did, that a discord remains identical in dissonance when transposed in sequence. He, like Prof. Burt, also wishes to be assured that the subjects of the experiment were really judging dissonance and not some other quality, such as "interestingness". He thinks Helmholtz, who was concerned with isolated chords, might possibly have agreed with results in which dissonance-level varied with the context. He wishes to see the results of a more effectively controlled experiment.

Mr. Chalmers Burns finds it surprising that a psychological experiment should be necessary to prove what musicians have known for many centuries, namely, that the harshness of a dissonance depends on the way in which it is used.

Gardner and Pickford, who appreciate these criticisms, cannot say that they were unaware of them beforehand, and if they are able to publish any further interesting experimental results, they will do so; but it is worth saying that one subject in their experiment, who has some musical experience, reported that a certain discord sounded very dissonant until the progression in which it appeared reminded her of Debussy, and then it became consonant. Another subject, who has less musical experience, was unable to find any discords whatever in the whole experiment, though by musicians' standards some of them were certainly very harsh indeed.

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[1] Nature, 152, 570 (1943).

Future of Quaternions

Prof. E. T. Whittaker, in his recent presidential address to the Royal Society of Edinburgh[1], has revealed the brilliant future which awaits the great Hamiltonian algebra in the domain of relativity.

Hamilton's great step forward in the initiation of his algebra lay in his perception that a vector could be used to indicate *either* a linear *or* an angular displacement. Further, the quaternionic algebra (with altered name) can be generalized to n dimensions. For example, in four dimensions, it is a vector volume that obeys Hamilton co-equally with the linear vector. There are also present vector planes both in and perpendicular to the three-dimensional constituent. The linear vector in the fourth dimension, taken as a Hamiltonian versor, at once indicates *no* fourth dimensional translation, but rotation in the three-dimensional constituent—the curved path of light.

Prof. Whittaker thinks that it was the physicists who neglected quaternions from their intrinsic mathematical difficulty. My experience has been different in dealing with students. It was the mathematicians who turned from the quaternionic algebra because of its summation of scalar and vector quantities. In view of their ready use of complex algebra, it is not easy to see why that should have occurred.

In conclusion, I would like to give the following extract from Tait's preface to the third edition of his "Quaternions".

"With regard to the future of Quaternions, I will merely quote a few words of a letter I received long ago from Hamilton:—'*Could* anything be simpler or more satisfactory? Don't you *feel*, as well as think, that we are on the *right track*, and shall be *thanked* hereafter? Never mind when.' The special form of thanks which would have been most grateful to a man like Hamilton is to be shown by practical developments of his magnificent idea. The award of this form of thanks will, I hope, not be long delayed."

Now Whittaker, heralding the dawn of that day, half a century after Tait gave that quotation from Hamilton, has given both Tait and Hamilton the needed thanks.

W. Peddie.

[1] See Nature, **152**, 603 (1943).

SOCIETY OF AGRICULTURAL BACTERIOLOGISTS

THE Society of Agricultural Bacteriologists shows each year a fresh increment of growth. This is partly due to the increasing attention which is being given to the study of bacteriology in relation to agriculture and partly to a gradual change in the composition of the Society. For some years it has been attracting a steadily increasing number of bacteriologists working in university departments and research establishments of various types, and in industries other than agriculture. Indeed, all the main branches of bacteriology outside the medical field are now represented among the members. The present policy of the Society is, by opening its membership to bacteriologists in different fields and by making contact with other societies and groups interested in the study of microbiology, to assist in the evolution of an association which will represent all the various branches of bacteriology in Great Britain.

The annual conference of the Society was held this year at Leeds during September 8–10. The majority of the papers were concerned with problems associated with the dairy industry, but several other aspects of bacteriology were represented.

The chlorination of sewage and sewage effluents, a practice which may be desirable in special cases of sewage disposal, was the subject of a paper which described the principles involved and gave the results of experiments showing the effect of chlorination on the bacterial population.

Interest in sandbags has led to the development of an accelerated test for textile preservatives. Pieces of treated and untreated fabric are fixed on aluminium frames and partially buried in containers filled with soil; the soil is held at 30° C. and at a constant moisture content so that cellulose-decomposing organisms may become active, and the strength of the samples is tested weekly.

A paper on the *Bacillus subtilis* group in relation to industrial products dealt with the activities of *B. subtilis* (an organism which is frequently identified as *B. mesentericus* or *B. vulgatus*) and of *B. licheniformis* in dairy products, canned foods, bread, sugar juices and other materials. Factors determining the occurrence of the organisms and controlling their growth were described.

A contribution dealing with the bacteriology of potato silage reported that no evidence could be obtained that any of the lactic acid bacteria survive the cooking of the potatoes. It appears that in practice the lactic acid fermentation, on which preservation depends, is due to accidental contamination. Excellent results have been secured by inoculating the cooked tubers with a combination of *Streptococcus lactis* and *Lactobacillus plantarum*.

A study of 'slowness' in cheesemaking has shown that certain cases are due to the occurrence in some milk of a streptococcus which produces a toxin inhibitory to the organisms of the starter. This example of bacterial antagonism was originally described in New Zealand and has now been observed frequently in Britain. The trouble is encountered most commonly when cheese is made from pasteurized milk; if raw milk is used the organisms which it contains can assume the functions of the starter.

Recent work on the pasteurization of milk has thrown new light on the effect of the process on the bacteria of raw milk, and the problem of the keeping quality of the product has thereby become clearer. The organisms which tolerate the treatment are corynebacteria, streptococci (chiefly *S. bovis* and *S. thermophilus*), micrococci and in certain samples aerobic spore-forming bacilli. Other bacteria are only rarely detected if recontamination does not occur. One paper reported the finding in 4 per cent of supplies of heat-resistant coliform organisms; the infection was traced to incompletely sterilized milking machines. There was some discussion of the bacteriological control of pasteurized milk, a subject which presents several difficulties owing to the conflicting results furnished by different methods. It was clearly brought out that the corynebacteria and many of the micrococci which survive pasteurization are unable to proliferate at 37° C., and their presence in pasteurized milk escapes detection by the plating method unless a lower incubation temperature is used.

Problems incidental to the condensing and drying of milk were discussed. Work on the bacteriology of dried milk powder and whey led to the suggestion that, as an interim standard, the plate count of a good quality roller-dried product, made within fourteen days of manufacture, should not exceed 5,000 per gm.

'Sterilized' milk, which is consumed in considerable quantities in certain parts of England, is not always sterile, and the findings of an investigation of this product were reported. The most important type of deterioration was found to be sweet curdling by spore-forming aerobes such as *Bacillus cereus* and *B. subtilis*. The trouble could not be related to the quality of the original milk or to the severity of the heat treatment, which varies from 30 min. at 218° F. to 1½ hr. at 225° F. in different plants, or to the efficiency with which bottles are sealed. Evidence was obtained that infection originates from inadequately sterilized plant and bottles, and that the organisms secure sufficient oxygen in a properly sealed bottle to allow of their multiplication. Abnormal flavours unaccompanied by visible changes in the milk were found to be produced by *B. thermoacidurans* and *B. circulans*, which may also be introduced from dairy equipment. Other papers dealt with sterilization in dairy practice and with bacteriological standards to be used in estimating the efficiency of the processes.

A case of 'ropy' milk due to a slime-forming coccus has been traced to infection from hay. A survey of samples of new hay showed that dust derived from this material may be a source of several species of bacteria which give rise to the abnormality. Coliform organisms isolated from hay were incapable of producing a slimy condition in milk.

Methods for the examination of milk continue to receive much attention. A recent innovation is the use of electrical methods for the rapid recognition of unsatisfactory milk. Souring is detected by a pH measurement, and mastitis milk, which is alkaline but has a high chloride content, is identified by means of a conductivity tester. Several papers were devoted to the methylene blue and resazurin reduction tests. The reduction of resazurin in pasteurized milk has been found to be unrelated to the plate count of bacteria which survive the heating. On the other hand, if milk shows rapid reduction in the raw state it behaves in the same way after pasteurization, thus suggesting that reducing substances resulting from bacterial activity in the raw milk are an important factor in post-pasteurization resazurin

tests. In the grading of raw milk a considerable proportion of samples are classified differently by the methylene blue test prescribed by the Ministry of Health and the routine resazurin test adopted provisionally by the Ministry of Agriculture, and further work on this problem is necessary. The complete reduction of resazurin has been shown to be generally slower than that of methylene blue in poor quality milk, but in the majority of samples with a good keeping quality it is similar or quicker. A study of the influence on dye tests of cells from the cow's udder has indicated that the amount of winter market milk which is reduced in grade owing to mastitis and late lactation is 4 per cent when the methylene blue test is used and about 10 per cent when the standard resazurin test is employed.

One of the papers on mastitis of the cow suggested the use of the Hotis test in routine laboratory diagnosis. After twenty hours incubation any samples which give a positive reaction are plated. This method, which economizes materials and labour, appears to be equal in reliability to direct plating.

A paper on the bacteriological aspects of blood transfusion discussed problems arising in the storage of blood and the production of plasma, and described methods of ensuring freedom from contaminating organisms. An account was given of the contaminants encountered in practice and of their action on blood and plasma.

The subjects discussed at this meeting of the Society show that problems in applied bacteriology which are largely related to war-time conditions are occupying the attention of the members. The dominant interest is in dairying, an indication of the national importance of milk and its products.

Copies of the Society's *Proceedings* containing the full papers can be purchased from the Hon. Treasurer, L. J. Meanwell, United Dairies, Ltd., Ellesmere, Salop.

MEASUREMENT OF HEARING AND DEAFNESS

AN article by M. B. Gardner (*Bell Lab. Rec.*, 22, No. 1; September, 1943) gives the results of tests carried out to determine hearing ability. Audiometers for measuring hearing loss vary considerably in arrangement, depending on how they are to be used and on how extensive a test is to be made. One of the models which has been widely used is the 2*A* audiometer manufactured by the Western Electric Company. It includes an adjustable oscillator as a source of single-frequency tones and an attenuator by which the intensity level of the tone may be varied. The person whose hearing is being tested listens to the tone through a small receiver, and is given a push-button with which he lights or extinguishes a lamp in front of the operator. Normal procedure is to have the lamp lighted as long as the tone is heard, and the patient extinguishes the lamp by releasing the push-button when the tone disappears.

Eight frequencies are provided from 64 to 8,192 cycles, which covers the important range of hearing, and the frequencies are selected as desired by keys on the audiometer. The output circuits for the various frequencies are so arranged that with the attenuator dial set to the point marked zero loss, the output of the receiver is at an intensity corresponding to the threshold of the average ear for that frequency. At this position of the dial the attenuator is inserting nearly its maximum loss—a small amount of additional loss being provided to enable measurements to be made on those who hear somewhat better than the average. The dial is graduated in 5db. steps. Normal procedure is to set the dial at a level that the patient can certainly hear, and then to reduce it step by step until the tone is no longer audible. The reading of the dial at the last step the patient hears gives his hearing loss at that frequency.

The intensities corresponding to the zero settings of the 2*A* audiometer, which represent the threshold of hearing for audiometric purposes, were obtained from tests on a group of people of normal hearing between the ages of twenty and thirty. They are on the average 10–15db. higher than the minimum audible pressure values given in an earlier article*. The objective of these values was to determine the minimum pressures that can be heard by the human ear, rather than the pressures heard under normal conditions by a more average group of people. That the values used by the 2*A* audiometer are well suited to their purpose is indicated by results obtained at the World's Fair in 1939. The threshold values of the 2*A* audiometer correspond very closely to those found during this survey.

Although the threshold curve is of fundamental importance in all acoustical work, there is another curve that is of interest, and that at times becomes of critical importance. As the level of a sound is increased above the threshold, the sound becomes louder and louder until the response becomes more that of the sense of feeling. The stimulus is felt rather than heard, and at somewhat higher levels becomes painful. A curve drawn through these pressures, at which the response is one of feeling as well as hearing, gives the so-called threshold of feeling, and marks an upper limit to audible pressures. The area between these two thresholds represents the range of audible sound pressures, and by plotting the results of audiometer measurements on such a field, it is possible to gauge at a glance the relative seriousness of any particular pattern of hearing loss. Charts indicating these two thresholds are usually employed when plotting hearing losses but, on them, the threshold of hearing is represented by a horizontal line near the top, and the threshold of feeling is plotted in decibels relative to the threshold of hearing.

Deafness may be due either to a transmission loss in the three bones of the middle ear, or to a reduced response of the auditory nerves. The former is called 'conductive deafness', and the latter 'nerve deafness'. With nerve deafness the loss usually increases at the higher frequencies. With conductive deafness, on the other hand, the loss is more constant with frequency, and may even be less at the higher frequencies. In addition, both forms of loss may be present, giving what is called mixed deafness. Even when it is not clear from the audiogram which form of deafness is predominant, the two types of deafness may be distinguished by other criteria. As a result of the lack of sensitiveness of the responding system that results from nerve deafness, no response is obtained until the stimulus reaches a certain value. Beyond this value, however, the response increases rapidly with the stimulus; so rapidly, in fact, that at high intensity levels individuals having one normal ear and one nerve-deafened ear judge the sound to be equally loud in either ear. With conductive deafness all sounds, of whatever level, suffer the same loss. The deafened person therefore hears more nearly

Bell Lab. Rec., 21, No. 10 (1943); see NATURE, 152 (Oct. 16, 1943).

like the normal individual, except that all sounds are reduced in intensity. Such an individual is not nearly so apt to complain of someone shouting too loudly as would the individual who has become affected by nerve deafness.

Those tested were asked to indicate their hearing ability according to five classes: (1) no noticeable difficulty in hearing; (2) unable to understand speech in public places such as churches or theatres; (3) unable to understand speech from a person two or three feet away; (4) unable to understand speech from a telephone; and (5) unable to understand speech under any condition. Their audiograms were then taken and recorded. Such tests were made on some 9,000 persons, and the audiograms of those of each of the five classes were then averaged to discover the amount and type of loss that was responsible for the various inabilities to hear. These results show, in a graph, that the five classes of loss are separated on the average by about 20 db. For those reporting normal hearing, the average loss was about 5 db., while for the other four classes it was 25, 45, 65, and 85 db., respectively, the latter figure corresponding to total deafness for speech.

STATISTICAL METHODS FOR GOVERNMENT DEPARTMENTS

THE "Memorandum on Official Statistics" issued by the Council of the Royal Statistical Society is a notable document, not merely for its recommendations for the post-war period, but also for the lucid and concise analysis of the pre-war period and the developments in war-time. The analysis of the pre-war period reflects little credit on the organization and method of the Civil Service. Each department collected its own statistics, and inadequate use was made even of the information available. The utilization of statistical material was imperfect and unsystematic, with loss of information and efficiency. No attempt was made to correlate the information with material available in other branches or departments. In only a few of the major departments was there any statistical organization which could be regarded as adequate. The staffing of departments was unsatisfactory in regard to the training of personnel and in certain respects to their status. Nowhere was a knowledge of statistical theory regarded as a necessary qualification for employment in statistical work, and the technical post of 'statistician' was practically unrecognized.

While the committee of the Royal Statistical Society which prepared the Memorandum is of opinion that in the pre-war period a good deal more could have been done by way of the analysis and interpretation of existing material, with great benefit to departments and to Ministers, it recommends that the collection of statistical material should continue, where possible, to be left to those departments and their branches the administrative duties of which bring them into daily contact with persons providing the information, so as to utilize the fund of experience acquired by administrative branches and the friendly relations which many of them have built up with their clientele. The branches may require advice from a co-ordinating statistical branch in the formulation of inquiries and the treatment of results, but the Memorandum is emphatic that the Central Statistical Office which is proposed to effect firm co-ordination of the statistical work of different departments should not relieve departments of their responsibility for collecting and compiling statistical data. Divorced so far as possible from routine analysis and from administration, it should be charged with the duty of preparing statistics required by the Government, such as the Budget White Paper, by Royal Commissions and by special committees appointed by the Government. It should ensure that as much statistical material as possible is made available to the public, and that all Government statistics are issued with the minimum of delay. It should endeavour to fill gaps in statistical information by advising departments on the desirability of certain lines of inquiry and should undertake research work or loan staff to assist other departments in undertaking such work.

Acting generally as a co-ordinating body, particularly through a small committee selected from the heads of statistical branches in the major departments, the Central Statistical Office should be responsible for the issue of the Statistical Abstracts for the United Kingdom and the "Guide to Current Official Statistics". It is suggested that the Office should also be responsible for the publication of a monthly bulletin of statistics on the lines of the Survey of Current Business issued by the United States Department of Commerce.

These are the principles on which the Memorandum considers the Central Statistical Office set up in 1941 should be reorganized after the War. The effect of the War has in fact been almost universally beneficial to statistics. The shortage of trained statisticians emphasizes the importance of the contribution they can make to the service of the State in the field of both descriptive and mathematical statistics. Some degree of internal training of the employees of statistical branches has been initiated, and increased use is being made of scientific aids to numerical work. There are also signs of a considerable change for the better in the public and departmental attitude towards statistics.

On the fundamental assumption that plans for reconstruction and for social reform will involve an increasing demand for comprehensive statistical information by the Government during the post-war reconstruction period and beyond, the Memorandum makes further recommendations. First, every major department should have a statistical branch under the direction of an administrative officer, and minor departments should either have a smaller unit or work under the guidance of the statistical branch in a major department or of the Central Statistical Office. Next, in regard to staff, certain statistical posts should be of grades equivalent to that of the more senior administrative officers, and the administrative personnel of statistical branches should be recruited from persons with mathematical or statistical qualifications; transfer between departments should be permitted where necessary. An endeavour should be made to post selected junior administrative officers to the statistical branch as part of their training, and technical posts of statistician created where departments consider them necessary. Full opportunity should be given for a technical statistician who showed administrative ability to be transferred to the administrative grade. The system of giving free courses in statistics to selected members of statistical branches should be extended and facilities given for advanced study. Opportunity should be given for members of statistical

branches to become familiar with the practical aspects of the matters with the statistics of which they are dealing.

The Memorandum also recommends transfer of personnel from departments to the Central Office and vice versa and, as already indicated, the staff of the latter should be available for assisting departments. The needs of certain departments for casual assistance should be met by providing the services of a mathematical statistician either by the appointment of a full-time officer, the loan of a suitable officer from the Central Statistical Office or the Department of Scientific and Industrial Research, the use of an advisory panel of experts, or by temporary engagement of a man from industry. The Memorandum particularly welcomes the interchange of expert personnel between industry and the Civil Service, and finally it is recommended that the Central Statistical Office or some other Government organization should ensure that the most effective use is made of modern machine methods.

The position of the Foreign and Colonial Offices, the Dominions Office and the India Office requires special consideration. In the Colonial Office at least, a statistical branch is recommended; but the responsibility for co-ordinating the trade statistics of the various Colonies should remain with the Board of Trade in view of the Board's experience in dealing with all trade statistics.

These proposals are parallel with those advanced on behalf of scientific workers generally, and which have commanded powerful support in recent reports and in debates in the House of Lords. The Memorandum is also in line with recent suggestions for Civil Service reform, including the training and recruitment of staff. Pronouncements of members of the Government in regard to the importance of statistics and the remedying of admitted defects in the existing service warrant the hope that this notable technical contribution to the improvement of the machinery of government will receive the official recognition that it well deserves.

A GAS-TUBE HARMONIC GENERATOR

IN a search for methods of obtaining currents of high and closely controlled frequency for carrier systems, the Bell Laboratories recently investigated the harmonics generated by triggering gas-filled tubes. The studies showed that gas tubes can produce much higher frequencies than had been thought possible, if operated in a new circuit which accelerates the ionization and de-ionization of the tube. The harmonics thus generated provide standard frequencies so high as 25 mc. for calibrating oscillators. The sharp current pulses are useful in testing television systems, for making phase distortion measurements in co-axial cables, and in high-speed triggering devices.

A typical gas tube with grid control is a triode filled at low pressure with mercury vapour or argon gas. If the grid is maintained at a constant negative potential with reference to the hot cathode while the plate potential is increased with reference to the cathode, only a very minute electron current passes to the plate until a critical plate-cathode potential is reached. This critical potential depends on the structure of the tube, the gas used and the magnitude of the grid potential as well as on the past history of the tube. When the critical potential is reached, an arc forms and the tube current suddenly rises. The voltage across the tube simultaneously decreases if an external load is connected in series with the source, and the tube continues to conduct until the plate voltage falls below a minimum value necessary to maintain the arc. When the arc is extinguished, the gas ions in the tube migrate to the tube elements and the tube finally becomes de-ionized. As the tube becomes de-ionized, the grid again regains control and the above process may be repeated. The time required for de-ionization determines the frequency at which the foregoing cycle may be carried out.

In the new harmonic generator circuit, the grid and plate are both supplied from the same A.C. source. This makes the plate voltage not only decrease to the value required to extinguish the tube, but also continue to a negative value. Likewise the grid voltage becomes negative. The negative potentials, primarily that on the grid, sweep the gas ions quickly from the tube, thus increasing the rate of de-ionization and the maximum frequency at which the tube can operate. An article by L. G. Kerota (*Bell. Lab. Rec.*, 22, No. 2; October 1943) describes the new circuit, its operation and performance.

In one practical application the gas-tube harmonic generator is used to test the fidelity of television-receiving equipment. Because it generates sharp wave fronts of controllable duration, black-to-white signal changes of great rapidity can be obtained. For determining the phase shift of signals in co-axial cables, two gas-tube circuits operate synchronously. Signals from one are used locally, and those from the other are transmitted over a looped line. The phase shift is determined by observing the difference between the wave fronts of the two pulses.

BIOLOGICAL RESULTS OF THE LAST CRUISE OF THE *CARNEGIE**

THE present publication, the sixth of the series and the fourth devoted to biological reports, includes accounts of the phytoplankton by Herbert W. Graham, the marine algæ by William Albert Setchell, polychætous annelids by Aaron L. Treadwell, the mysids by W. M. Tattersall and, in addition, several smaller papers in various groups.

The phytoplankton samples, chiefly from the open ocean, were taken at the surface, 50 m. and 100 m., and collected by the Petterssen plankton pump. The main contents were diatoms and dinoflagellates. The area investigated is here divided for convenience into three regions: the southern region in the south-eastern Pacific between South America and longitude 120° W., the tropical region extending from Panama and Peru as far west as Guan, and the northern region between Yokohama and San Francisco. All were poor in phytoplankton. In general, the richest samples occurred in water of low temperature, lower salinity, lower pH and higher phosphate content, whereas little correlation could be found between numbers of plant cells and percentage saturation of oxygen, or between number of plant cells and quantity of dissolved silicate. An interesting condition

* Scientific Results of Cruise VII of the *Carnegie* during 1928–29 under Command of Captain J. P. Ault. Biology, IV. Department of Terrestrial Magnetism. (Pub. 555.) Pp. vi+92. (Washington, D.C.: Carnegie Institution of Washington, 1943.)

was found in the northern region, where all but two samples showed supersaturation in the upper 100 m., the diatom and dinoflagellate populations being very low. This is probably to be explained by the presence of minute photosynthetic organisms not captured in the ordinary filter net.

The mysid collection, described by the late Prof. Tattersall, although not rich in species or individuals (with the exception of *Sirella thompsoni*), is of interest in containing rare and new forms, and the geographical range of those already known has been extended. Two are new to science. One of them represents a new genus named Carnegieomysis, only one specimen of which was obtained; it is a curious and anomalous mysid the affinities of which are obscure until the male can be examined. The eyes are peculiar and of a unique character, resembling those of certain euphausians, having the cornea divided into distinct dorsal and ventral parts. In this case, however, the two parts are separated by a groove in which the corneal elements are absent. It is a type of eye which is developed in response to a pelagic habit of life. Apart from the eyes, the most outstanding characters are the form and size of the antennal scales and the shape and armature of the telson.

Shorter papers report on the isopods, halobates, birds, a sponge, echinoderms, insects and mites, pyrosomids and a lizard.

FORTHCOMING EVENTS

Saturday, January 15

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Inaugural meeting at the new meeting rooms, Sir Henry Dale, Pres.R.S., in the chair: Address by Mr. W. E. Watson-Baker, President of the Quekett Club; Special exhibition of members' work.

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 2.30 p.m.—Annual General Meeting. Presidential Address.

Monday, January 17

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Mr. J. N. L. Baker and Mr. E. W. Gilbert: "The Doctrine of an Axial Belt of Industry in England."

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Problems Night.

Tuesday, January 18

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Debate: "That the Programme of Social Security set out in the Beveridge Report should be Supported on Eugenic Grounds".

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Comparative Merits of Different Types of Directive Aerials for Communications" (to be opened by Mr. J. A. Smale).

Wednesday, January 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Henry Berry: "London's Water Supply".

INSTITUTE OF FUEL (at the James Watt Memorial Institute, Great Charles Street, Birmingham), at 2.30 p.m.—Mr. R. Whitfield: "Fuel and Metallurgical Furnaces".

GEOLOGICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Dr. E. B. Bailey, F.R.S.: "Tertiary Igneous Tectonics of Rhum (Inner Hebrides)".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, London, S.W.7), at 4.30 p.m.—Annual General Meeting. Prof. D. Brunt, F.R.S.: "Progress in Meteorology".

Thursday, January 20

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. H. W. Thompson: "The Scope and Limitations of Infra-Red Measurements in Chemistry" (Tilden Lecture).

Friday, January 21

INSTITUTE OF FUEL (at the Royal Technical College, Glasgow), at 5.45 p.m.—Dr. E. W. Smith: "Education in the Fuel Industries".

Saturday, January 22

BIOCHEMICAL SOCIETY (at the British Postgraduate Medical School, Ducane Road, Shepherds Bush, London, W.12), at 11.15 a.m.

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (joint meeting with the Midland Branch of the Institute of Physics) (at the University, Edmund Street, Birmingham), at 2.30 p.m.—Discussion on "Space-Charge and Noise in Radio Valves" (to be opened by Dr. P. B. Moon and Dr. R. R. Nimmo).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTERS for (*a*) CHEMISTRY AND MATHEMATICS, and (*b*) PHYSICS AND GEOGRAPHY, at the East Ham Technical College—The Secretary for Education, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E.6 (January 22).

PRINCIPAL of the Croydon Polytechnic and Evening Institutes—The Education Officer, Education Office, Katharine Street, Croydon (January 24).

LECTURER IN MECHANICAL ENGINEERING—The Principal, Derby Technical College, Normanton Road, Derby (January 24).

SPEECH THERAPIST (full-time)—The Director of Education, Leopold Street, Sheffield (January 25)

LECTURER (man or woman) IN ZOOLOGY—The Principal, Huddersfield Technical College, Huddersfield (January 31).

ENTOMOLOGIST in the Department of Agriculture, Salisbury, Southern Rhodesia—The Official Secretary, Office of the High Commissioner for Southern Rhodesia, 429 Strand, London, W.C.2 (January 31).

LECTURER IN PHYSICS—The School Secretary, St. Mary's Hospital Medical School, London, W.2 (February 1).

PRINCIPAL of the Gloucestershire College of Domestic Science and Training College—The Secretary, County Education Office, Shire Hall, Gloucester (February 5).

REGISTRAR—The Principal, University College of Wales, Aberystwyth (February 10).

CHAIR OF BOTANY tenable at King's College, and CHAIR OF BOTANY tenable at Birkbeck College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 21).

LECTURER IN CHEMISTRY FOR MEDICAL STUDENTS—The Acting Secretary, University Court, Glasgow (February 25).

UNIVERSITY CHAIR OF ANATOMY tenable at St. Mary's Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 20).

TEMPORARY TECHNICAL ASSISTANT IN FARM ECONOMICS under the Department of Agriculture for Scotland—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.1944.A).

ASSISTANT ELECTRICAL ENGINEER for the Nigerian Government Public Works Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 538).

ELECTRICAL ENGINEER (temporary) for a Government Department at Bath, to deal with the design and installation of loud-speaker and broadcast systems—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.734.A).

ASSISTANT MASTERS for (*a*) GENERAL SCIENCE with MATHEMATICS, to take charge of laboratories, and (*b*) ENGINEERING SUBJECTS with MATHEMATICS in Day Technical School and Evening Institute—The Principal, Technical Institute, 28 Beckenham Road, Beckenham, Kent.

TWO SCIENCE TEACHERS, one a male teacher, main subject PHYSICS, with subsidiary Chemistry or Mathematics; the other, male or female teacher for GENERAL SCIENCE, with some Biological background—The Principal, Technical Institute, Rochester.

TWO (full-time) ASSISTANT TEACHERS for (*a*) SCIENCE and/or MATHEMATICS, and (*b*) GENERAL TECHNICAL SUBJECTS including Woodwork or Metalwork—The Principal, County Technical College, Stoke Park, Guildford, Surrey.

LECTURER (full-time) in MECHANICAL ENGINEERING to teach up to Higher National Certificate standard—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19.

DEMONSTRATOR (full-time or part-time) IN PHYSICS—The Secretary, King's College of Household and Social Science, c/o University College, Leicester.

REPORTS and other PUBLICATIONS

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Bulletin No. 126: Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1933–1942. Pp. iv+100+8 plates. (London: H.M. Stationery Office.) 2*s*. net. [2412

Royal College of Surgeons of England. Scientific Report for the Year 1942–1943. Pp. 24. (London: Royal College of Surgeons of England.) [2412

Other Countries

Trabajos del Instituto Nacional de Sanidad. Estudio experimental de una cepa apatógena e inmunizante de Rickettsia Prowazeki, Cepa E. Por Dr. G. Clavero y Dr. F. Pérez Gallardo. Pp. 30. La prueba intradérmica de Giroud en la infección tifoexantemática: Nuestra experiencia personal, técnicas y posibilidades de su aplicación. Por Dr. G. Clavero y Dr. F. Pérez Gallardo. Pp. 66. Investigación del virus tifoexantemático en las ratas de España. Por Dr. G. Clavero y Dr. F. Pérez Gallardo. Pp. 26. Tecnicas de Laboratorio en el tifus exantemático. Por Prof. Dr. G. Clavero del Campo y Dr. F. Pérez Gallardo. Pp. 186. (Madrid: Instituto Nacional de Sanidad.) [1712

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TRAINING AND RECRUITMENT FOR PUBLIC SERVICES

ALTHOUGH the appointment of Lord Woolton as Minister of Reconstruction is evidence of the importance which the Government now attaches to post-war reconstruction, it has raised afresh the whole question of the machinery of government. Just as in the four years 1914–18, the stress of war has brought to light the weaknesses of the peace-time machinery of government in Great Britain. Deficiencies at the policy-forming level, where the current purposes and objectives of government are thought out and harmonized, converted into definite policies, made administratively viable and translated into practical plans and directions for those who have to execute them, have been clearly revealed, and have sometimes formed the subject of constructive criticism, notably from the Select Committee on National Expenditure. Equally conspicuous have been the defects in the machinery for finding facts, for co-ordinating available knowledge and facts, and for drawing significant inferences from them.

The proposals for the reform of the Foreign Service laid before Parliament by Mr. Eden some time ago*, which have been so warmly welcomed, may undoubtedly be regarded as an attempt to remedy some of the defects from which Great Britain has suffered in the last two decades in one branch of government, in so far as the determination, co-ordination and interpretation of facts are concerned. It does not, of course, except indirectly, affect the policy-forming level in that field, which, as was emphasized by Mr. Law in presenting the proposals to the House of Commons, is not the responsibility of the Foreign Service, but of the Cabinet and ultimately of Parliament. That aspect of the question was well analysed by Political and Economic Planning (P E P) in Broadsheet No. 201, on "British Foreign Policy", issued a year ago. More recently, in Broadsheet No. 213, on "The Future of Foreign Publicity", P E P has returned to the information and fact-finding aspects, and detailed some further suggestions for implementing the foreign policy laid down by the Cabinet.

While the discussions at present proceeding about Government and industry and the maintenance of controls have equally tended to direct attention to the machinery of government, it cannot be said that fundamental questions have been explored quite so thoroughly. Certain suggestions have been advanced, for example, in the Nuffield College Statement "Employment Policy and Organization of Industry After the War" ; but on the other hand, while the question of the Civil Service itself has been thoroughly examined in a number of reports, even where the larger question of machinery of government is faced, as in the report of the Sub-Committee of the Liberal Party on Civil Service Reform, comment rarely goes further than the submission that the whole structure of government from Cabinet level downwards requires authoritative discussion. The reconsideration of the

*Cmd. 6420. (London : H.M. Stationery Office.) 2*d.* net.

present functions and machinery in the light of the principles laid down in the Haldane Report finds an increasing volume of support; what is required is not so much fresh inquiry as fundamental thinking on the application of the principles laid down in that report to the problems of government to-day.

Some such analysis was attempted by Political and Economic Planning in a broadsheet on the machinery of government which appeared in July 1941. That broadsheet was concerned with the adequacy of the Civil Service and with the reforms required to make it an effective instrument of government; its proposals found strong support in a subsequent report from the Select Committee on National Expenditure in the 1941–42 session, which may well take its place with the Haldane Report as a State paper of first-class importance. No less fundamental are the observations on the machinery of government in the fourteenth report of the Committee in the 1942–43 session. Political and Economic Planning has now carried its analysis a stage further in Broadsheet No. 214, on "A Civil General Staff", devoted particularly to the machinery required to facilitate the organization and co-ordination of national policies and their execution at a level intermediate between the Cabinet as a whole and the individual Minister.

This is the main problem which Lord Woolton has to face. Whereas at the Ministry of Food Lord Woolton's task was largely that of administering a defined and simple policy, with the advantage not only of a very competent higher staff but also that the field had been very thoroughly prepared before the War, the Ministry of Reconstruction is not primarily administrative. Lord Woolton's task is not to take the decisions himself, but to see that the right decisions of policy are taken without delay. It will require the statesman's vision to see problems in the dimensions of history, and the politician's art in getting things done. From Lord Woolton the task will demand boldness as well as vision; from the small but influential staff, on the model of that of the Ministry of Defence, rather than of the ordinary ministry, it calls for clear thinking.

However gifted a statesman Lord Woolton may prove to be, success in his present post will depend largely on how far the whole Government machine is attuned to meet the demands which the post-war period, as well as the transition from war to peace, will make upon it. Some attempt must be made to deal with the fact-finding machinery and with that for co-ordinating and timing policy so as to eliminate the more glaring defects. Some improvements have, in fact, recently been suggested in the memorandum on official statistics issued by the Council of the Royal Statistical Society (see NATURE, January 15, p. 88), which urges that the statistical units of Government departments should in future be staffed by trained men, the departmental units co-ordinated and the Central Statistical Office continued and developed. This important technical contribution to the improvement of the machinery of government is supported by the observations in the sixteenth report for the session 1942–43 of the Select Committee on National Expenditure, which lead to the recommendation that the provision of the full and informative records showing the extent and variety of State assets which the Government must have at its command to make decisions on policy concerning the disposal of such assets in post-war reconstruction, and the collection, classification and co-ordination of departmental inventories should be undertaken by some central agency.

These are matters of detail which may eliminate some of the creaking and facilitate the smooth running of the Government machine. They will not in themselves—though not entirely minor matters—obviate the need for creative thinking about the functions and organization of departments and their inter-relations so as to serve more effectively the needs of to-day. The main divisions suggested in the Haldane Report are not necessarily those which will best fit the post-war need; war-time needs have provided experience of the possibilities of regrouping ministries, and even introducing new ones, which at least require exploring. A Ministry of Industry, including the industrial branches of the Board of Trade and some sections of the Ministry of Production, leaving the Board of Trade to be concerned essentially with international problems, is one suggestion that has been advanced, while clearly the functions of the ministries concerned with housing and health require thinking out afresh in terms of the post-war pattern.

Whatever form such re-organization may take, its ultimate success will depend on the men and women who will be called upon to administer policy and execute decisions. It is almost universally admitted that this will involve the recruitment of new kinds of Civil servants. So far as the Foreign Service is concerned, that is implicit in the White Paper proposals and was stressed in the subsequent debate. More generally, it is required not because the Civil Service is inefficient or incompetent, but because the present Civil servants are brought up too narrowly to discharge expertly and with understanding the many new duties of control and oversight which have been forced by events upon the modern State.

That might fairly be described as the burden of the criticism in the House of Commons debate, and both the merging of the Foreign Office, the Consular, the Commercial Diplomatic and the Diplomatic Services into one Foreign Service and the measures proposed for widening the recruitment and training for the Foreign Service are designed to remove this acknowledged defect. Criticism of the proposal to supplement the preliminary competitive entrance examination by a method based mainly on selection, as voiced in the debate, was essentially constructive, though the examination system found staunch defenders, subject to special entry for exceptional and outstanding men only. Similarly, the proposed scheme of training in which the competitive examination is taken in two parts, the second following a period of training abroad, with subsequent training of the successful candidates for a year in Great Britain, partly in the Foreign Office and partly in getting a grounding in economic, commercial and social questions, was also very fairly considered with

the view of obtaining as representative recruitment as possible from all sections of society.

The importance of the general outlook and strata of the nation finding faithful reflexion in the Foreign Service, in order that the Service may be abreast of the current life and activities of the country and represent it abroad, was universally admitted, as well as the necessity of ensuring that the Service possesses the necessary qualities of personality and character as well as of intellect. It is the fusion of politics and economics in foreign affairs so strongly emphasized in a recent report of the Select Committee on National Expenditure to which Mr. Law referred, which has made it so much more difficult for the Foreign Service, as previously recruited, to fulfil adequately its double function: that of advising the Government and giving the Cabinet a background of information about foreign countries; and that of representing the Government and the country abroad, trying to execute the policy upon which the Cabinet is determined in those countries, and promoting British interests, of which international peace and understanding are the most important, within the limits set out by the Cabinet.

Mr. Law's speech did something to put criticism of the Foreign Office in its right perspective, but even those who paid tribute to the present system recognized that there have been occasions in recent years in which its information service appears to have been defective. Much that was said, however, on such matters in this debate was almost as relevant to the Civil Service as a whole as to what it is now proposed to constitute as a wholly independent Foreign Service. The Civil Service cannot be expected to function with full efficiency unless it is sufficiently representative and in touch with the temper and outlook of the whole nation.

Conversely, it must be remembered that the spirit and efficiency of the Civil Service, including the Foreign Service, reflect the temper and interest of the community it serves and from which it is drawn. No machinery will provide us with a Civil Service of the highest ability and integrity, imbued with vision, initiative and enthusiasm, unless the mutual understanding and respect between the Service and the community whose interests it serves and safeguards are such as to encourage recruits of the requisite standard to enter the Service. No matter what training is given to recruits after entry, the merits and defects of the educational system of the country as a whole are bound to affect the tone and standard of its public services.

Recognition of this truth has led the British Association Committee on Post-War University Education to give special consideration to education for the public services. A report on that subject has now been issued, in which are considered the relations between universities and government administration, including the question of graduate schools for future or existing Civil servants, combining university work with practical experience in government offices. Using the terms 'government administration' and 'Civil Service' in the broadest sense to cover the local government service, the colonial service, the public utility corporations and services involving international co-operation as well as the home and foreign branches of the Civil Service proper, the education of those intending to enter such services or indeed corresponding careers in large-scale enterprise is related to that of university studies in general discussed in the first interim report of the Committee. The necessity of adapting the curriculum to present-day needs and conditions, and the increasing danger to higher education involved in the growth of over-specialization in many branches of knowledge apply with as much force to those intending to enter any branch of the public services as to any other type of university student. Apart from this, it is urged that any broad discipline can be made to meet the needs of intending Civil servants, provided it is taught in such a way as to train students both to generalize from given data and to question or verify against experience the processes of their reasoning.

There are three distinct aspects of the problem: first, education before entry into the senior branch of service; second, provision for higher officials to renew contact with the university during their official life; and, third, opportunities for education of a higher type for officials of lower rank as a stimulus and as a means of attaining promotion. In regard to the first, the report makes some pertinent comments in regard to those intending to enter any of the careers which involve regular co-operation with foreigners, whether in the diplomatic services, in such work as that of the British Council, in official or unofficial international organizations, in business or in journalism. It is essential for those entering upon any form of foreign service to overcome our notorious embarrassment or inhibition in our relations with those whose background, outlook and language differ from our own.

The British Association Committee considers that there is scope for a form of education designed to facilitate the process of international co-operation, and the experience of the Geneva School of International Studies over the fifteen years 1924–39, is cited to show that this can be done with success in a carefully designed six weeks' course for a body of students not too large to form a single social unit. In such a school there is a double process of cross-fertilization between intellectual disciplines as well as between national outlooks, and this also is important. Some specialization is inevitable in the foreign services. Its proportion may well be diminished somewhat by Mr. Eden's reforms, but the number of specialists engaged may well be increased. Scientific workers, for example, will probably figure more prominently than hitherto in some aspects of international co-operation, as the experience of the War clearly shows; and they too should welcome the demonstration that there is a technique for at least facilitating international co-operation and acquiring the appropriate attitude of mind.

With regard to the second aspect of the problem, this report takes up the suggestion put forward by Mr. H. E. Dale in his book "The Higher Civil Service" of a period of long leave within a few years after entering the Service. This, it is suggested, would

usually be most profitably spent in attending an advanced course in social studies, especially in the atmosphere and surroundings of a college undertaking research as well as teaching. Further, most of the future members of the higher Civil Service should spend the six winter months of a sabbatical year, before the end of the first ten years of official life, in following one of these courses in a civil service college at a university, and devote the six summer months of this year to acquiring inside knowledge of the working of one or more foreign civil services or of the international secretariat of the League of Nations.

To provide for the third aspect of the problem, the Committee recommends the institution of courses of similar duration for members of the lower branches of the Civil Service. These would be designed to provide the substance of a university education for Civil servants of proved ability who have hitherto been denied one, and to open new avenues for their promotion; and the results of the examination at the end of the course would influence the prospects of the candidate. In this way it might well prove possible to tap fresh sources of ability which would enrich the public service out of all proportion to the difficulties and expense involved in working out the plan.

This report of the British Association Committee is supplemented by a memorandum on "American Education for the Public Services" by Mr. Willard Connely, which lays welcome stress on the importance of ethnographical study in international relations. While the report shows that there is still some confusion of opinion as to the functions and purpose of a staff college, it should stimulate further discussion on this important question of training and recruitment for the public services, and help to place it in a fitting perspective in the programme of educational reform to which the Government is now committed. That programme itself should help to throw up recruits of the requisite ability and character from ever-widening circles of society, and at the same time promote the harmonious and sympathetic relations between the official and those he serves, upon which as well as upon the training and integrity of the Civil servant himself the full efficiency of public administration always depends.

SCIENTIFIC ETHICAL PRINCIPLES

Evolutionary Ethics

By Prof. Julian S. Huxley. (The Romanes Lecture delivered in the Sheldonian Theatre, 11 June 1943.) Pp. 84. (London: Oxford University Press, 1943.) 2*s*. net.

A FEW weeks ago, at a session of the B.B.C. Brains Trust (at which Prof. Julian Huxley was not present), the opinion of the members was asked on a suitable ethical basis for modern thought and action. One member spoke up for orthodox Christianity, but, from the rest, there was complete silence. Much the same reaction would probably be obtained from any half-dozen people selected at random from the Western Democracies. Prof. Huxley, in his Romanes Lecture on "Evolutionary Ethics", sets out to fill this partial vacuum with an exposition of ethical principles and practice based on the scientific approach to life and its problems and, in particular, on the facts of evolution.

Ethics has three distinct, though interrelated, aspects, which may be epitomized in three questions: How do we come to make moral judgments at all? What reason, if any, have we for thinking that one judgment is right and another wrong? On what specific moral judgments ought we, in practice, to base our actions? The first is concerned with the developmental 'natural history' of ethics, the second with what Waddington has recently called "the age-long endeavour to find an intellectual basis for ethical judgements", and the third with practical or didactic ethics.

On the first question, Prof. Huxley expands the thesis, put forward earlier in his "Uniqueness of Man", of the evolutionary significance of the development in the human infant of what he calls the "proto-ethical mechanism". He accepts, broadly, the Freudian view that ethical judgments are a product of the child's conflict between its feelings of love for its mother as the provider of comfort and satisfaction, and its feelings of hate and aggression for that same mother as the authority which, frequently and necessarily, denies to the child the enjoyment of the comfort and satisfaction for which it longs. This conflict takes the form of 'all or nothing' alternations of love and hate, which persist, at varying levels of consciousness, into adult life, and, becoming transferred to such "objects" as sin, virtue, native land or racial group, constitute the raw material of adult ethical judgments. From an evolutionary point of view, why should such a mechanism, involving the complete suppression, at a given moment, of one or other of the opposing emotions, have been developed? Prof. Huxley interprets it as a device for securing "action rather than indecision in the face of conflict", and, as such, it clearly has survival value in the struggle for existence. In addition, however, the mechanism, by attaching a load of guilt to one of the conflicting impulses, weights the scales between them, and has the effect of securing one particular kind of action rather than another. In one of the many memorable phrases in his lecture, Prof. Huxley thus sums up the situation: "Primitive love conquers primitive hate by saddling it with the burden of primal guilt; and with this the polarity of right and wrong becomes attached to our thoughts and actions".

The child, then, enters on its passage to maturity equipped with this primitive and absolutist ethical mechanism, and the main problem confronting it is to adjust this mechanism to the facts of external reality by incorporating experience with the aid of reason.

The degree to which the mechanism does, in fact, become adjusted to reality varies enormously. In any society there are a number of individuals bearing a heavy burden of unrealistic guilt, while the ethical standards of all human groups are themselves more or less unrealistic. Nevertheless, in favourable circumstances, human beings *are* able to develop without such "overdoses of untruth and unreality in their moral system", and it is in the growth of an outlook preserving a balance between the emotional driving force of our infantile proto-ethics on one hand, and the guiding influence of ordered experience on the other, that Prof. Huxley sees the hope of ethical progress in the future.

This, very briefly, is Prof. Huxley's account of the 'natural history' of ethical judgment, and the mention

of ethical progress leads to the second question referred to above, the search for an objective criterion of ethical rightness and wrongness—a search which Wittgenstein once described as "a terrible business—just terrible! You can at best stammer when you talk of it."

For the solution of this "terrible business" Prof. Huxley looks to the concept of evolutionary progress, and the corner-stone of his thesis is that our ethical standards are not static but constantly evolving. "Our ethics," he says, "evolve because they are themselves part of the evolutionary process. And any standards of rightness or wrongness must in some way be related to the movement of that process through time." He goes on to define evolutionary progress as "the capacity to attain a higher degree of organization without closing the door to further advance", and points out that, with the advent, on the evolutionary stage, of human speech and conceptual thought, it became possible, for the first time, for one of the products of the evolutionary process, namely man, to take a conscious part in it and to inject into the hitherto blind and automatic mechanism the concept of moral purpose. This marriage of evolution and morals gives rise to three main principles of evolutionary ethics, namely, "that it is right to realize ever new possibilities in evolution, notably those which are valued for their own sake; that it is right both to respect human individuality and to encourage its fullest development; that it is right to construct a mechanism for further social evolution which shall satisfy these prior conditions as fully, efficiently, and as rapidly as possible". Prof. Huxley then goes on to show how these broad principles can be applied to a number of current and recurrent ethical and social questions.

This picture of moral purpose as part and parcel of evolutionary progress, and the programme of social change derived from it, will undoubtedly provide a stimulating inspiration to progressive thinkers at the present time, but one is left with the question whether Wittgenstein's "terrible business"—an objective intellectual basis for ethics—has, in fact, been satisfactorily settled. Prof. Huxley lays great stress on the development of emotional experiences which have "inherent value" or which "are valued for their own sake", and such experiences form, in effect, the core of his theory of ethics, as indeed they must of any naturalistic ethical theory. Is the criterion of the value of these experiences an intellectual one? Surely, on final analysis, we must agree with Hume, that the assessment of such values is fundamentally dependent on the *emotional feelings* of individuals or groups of individuals, feelings of which we can approve or disapprove, the origin of which we can trace, but for which, from their very nature, we cannot find any intellectual justification. Is not Wittgenstein's "business" so "terrible" precisely because there does not exist any intellectual basis even to stammer about?

To take this view does not, however, detract from the great value of Prof. Huxley's essay as a synthesis of the scientific and ethical approaches to human problems. If moral truths are banners which inspire the emotions, rather than statements which satisfy the intellect, the Romanes Lecture for 1943 must be reckoned as a notable standard for rallying the forces at present struggling to find a basis for ethics in harmony with scientific thought and untinged with the tenets of revelationary religion.

J. S. L. GILMOUR.

TECHNIQUE OF BLOOD-GROUPING

The Determination of Blood Groups

Medical Research Council War Memorandum No. 9. Pp. 28. (London: H.M. Stationery Office, 1943.) 4*d*. net.

It is doubtless true that on the great majority of occasions blood-grouping can be carried out correctly in a high proportion of cases even when the simplest procedure is used by the relatively inexperienced. But when the consequences of a mistake may be disastrous, as in blood-transfusion, and it is essential to get very near the limit of complete accuracy, it is found, as is so often the case in tests of biological material, that this can only be done by elaborate and meticulous technique in the hands of well-trained and experienced workers.

The Blood Transfusion Research Committee of the Medical Research Council has produced an admirable memorandum on this subject. A particularly lucid account is given of the principles underlying correct grouping and of the various sources of error which have been revealed by the wide experience of many workers.

The procedure of choice is a tube method, the cells being tested for agglutinogens and the serum for agglutinins. Direct matching of the donor's cells against the recipient's serum is also carried out. Should time and the necessary glassware render the tube method impracticable, a tile method may be used. In this case it is recommended that undiluted blood should not be used except by workers with long experience of the method.

The methods advocated are described in full detail, and it is recommended that one or other should now be followed by all transfusion services, without the introduction of personal modifications by less experienced workers. As the membership of the Committee shows, these recommendations have the highest authority behind them. They will doubtless be universally adopted.

An interesting account is given of the *Rh* factor, of which so much has been heard lately. There are two ways in which *Rh*-negative persons may develop in their serum immune bodies capable of agglutinating the cells of *Rh*-positive donors. The first is their development by the *Rh*-negative mother carrying an *Rh*-positive fœtus—the cause of the great majority of cases of erythroblastosis fœtalis. The second is the response of an *Rh*-negative recipient to transfusion with *Rh*-positive blood. The ideal method of preventing trouble due to these causes would be the use of *Rh*-negative blood only for *Rh*-negative recipients. Under peace-time conditions this may become possible; it may be that in the future the standard blood for transfusion will be *Rh*-negative as well as of Group *O*. In war-time this is quite impracticable. The Committee makes, however, a series of recommendations which should greatly reduce the dangers.

The practical business of blood transfusion is, of course, all-important; but the records do provide in addition a by-product of great value in the field of pure genetics. In genetics it is difficult to draw a line between pure and applied research. Any animal or plant may on occasion provide material for fundamental work. Man furnishes such an opportunity in connexion with the blood-groups, for more is known about the geographical variations of the fre-

quencies of these genes than is known in the case of any other gene whatsoever. The enrolment in war-time of vast numbers of donors has produced a correspondingly great opportunity for the extension of knowledge. But it also increases the possibility of unreliable bodies of data. Mass grouping may, on occasion, be very inaccurate as, for example, when gross errors are made through such faults as the use of stale serum or infected cells. It is true that a small percentage of errors would not matter much from this point of view, so long as they were random. Often, however, they may not be random, in which case even a small proportion of wrong groupings might lead to erroneous conclusions. For example, in the British Isles, the population of which is serologically variable, variations in the frequency of gene A are of great interest, as shown by the work of the Galton Laboratory and its Serum Unit. If workers in one area, owing to a lack of the precautions described in the Medical Research Council memorandum, wrongly assign a number of A_2 and A_2B persons to groups O and B, while in a neighbouring area this source of error is absent, a false conclusion on geographical or racial variation might easily be drawn.

Bernstein's well-known test does to some extent provide a check; it can be discovered whether the observed group frequencies are in unreasonable proportion. But only one degree of freedom is available, so that a discrepancy is difficult to interpret. Furthermore, errors may cancel each other (as I found in one large body of material).

The Medical Research Council memorandum should lead to much improvement. It is true that the mass statistics will usually be obtained from the registration of donors, this being carried out at a time when cells alone can be tested. Nevertheless, gross errors and biased errors should be largely eliminated: a great gain in regard to this fleeting opportunity, automatically available during a war and at no other time.

J. A. FRASER ROBERTS.

STRUCTURE OF CLOUDS

Cloud Reading for Pilots

By A. C. Douglas. Pp. x+120. (London: John Murray, 1943.) 10s. net.

THIS excellently illustrated little book contains 164 photographs of clouds taken by the author, who is herself a pilot. The treatment of cumulus and altocumulus is especially good, and there are several series of photographs of the same cloud taken at short intervals, showing the changes in progress. The majority of the photographs are from the ground, but a few are from the air. Both the illustrations and the descriptive matter reveal a keen and intelligent observer.

The text contains a brief outline of the physical processes of cloud formation, and includes the usual text-book diagrams of ascending air at fronts. Actually these are highly simplified, and the real processes are still imperfectly understood, providing plenty of scope for future work, from the point of view both of meteorology and of aviation. The book contains some useful hints for pilots, but an attitude of caution should be adopted towards predictions deduced from cloud structures, since the actual sequences of events are extremely variable. Prof. Brunt, in his preface to the book, indicates how the pilot can co-operate with the meteorologist and help with his own observations.

There are no major errors, and though some statements are not quite accurate, very few of these refer directly to the clouds. Strictly speaking, altocumulus castellatus (p. 77) should refer to clouds above 8,000 ft., the lower type being stratocumulus castellatus. The roll type of cloud shown in Fig. 59 is not due to thermal convection. Emphasis is rightly laid on the importance of ice-crystals in anvils, and this also holds for altostratus and all clouds from which precipitation normally originates. The distant shower shown in Fig. 60, and the "virga" (precipitation below clouds) in Fig. 62 probably consisted of snow-flakes, which form threads much more clearly visible than those due to raindrops. Indeed the melting of snow-flakes may terminate the tufts of virga, though evaporation is more frequent. A nebulous or 'watery' sky is usually due to snow-flakes or small ice-crystals.

The book can be recommended to pilots, and meteorologists can study the photographs with advantage.

INSECTS OF MEDICAL IMPORTANCE

A Handbook for the Identification of Insects of Medical Importance

By Dr. John Smart; with Chapters on Fleas, by Dr. Karl Jordan, and on Arachnids, by R. J. Whittick. Pp. x+269+13 plates. (London: British Museum (Natural History), 1943.) 15s.

THE great importance of certain groups of insects and other arthropods as vectors of disease-producing organisms affecting man, is universally recognized. In this way the subject of medical entomology has come into being and it is one which displays continuous rapid growth.

With an insect believed to be implicated in disease transmission, the first requisite is to ascertain its name. Accurate identification is of paramount importance, since the behaviour of closely related species may be totally different and demand different repressive measures. In normal years, time and facilities are usually available for sending specimens to a central institution for naming by specialists. Under war conditions, however, such procedure becomes greatly interfered with and an undue amount of time lost before the desired information is obtained. Often the specimens and correspondence are liable to loss in transit and the whole matter has then to be reopened on a fresh basis. The present volume is intended to obviate these drawbacks by providing the means for the identification of any insect known to be of medical importance. It is concerned with all the Old World species that come under this category. An elementary knowledge of entomology is assumed, and users of the book will find, after some practice, very little difficulty in following the tables and descriptions. These, moreover, are accompanied by good clear illustrations, many of which are original.

The authors are to be commended on having written a reliable and up-to-date treatise well adapted in every way for the purpose it is intended to serve.

A. D. IMMS.

HUMAN BLOOD GROUPS

By J. F. LOUTIT

THE blood group of a person is dependent upon the presence in his erythrocytes of specific antigens. These antigens, most easily demonstrated by agglutination methods, are usually referred to as 'agglutinogens'. The corresponding antibodies, or agglutinins, may or may not be found naturally in human sera. If not found naturally, they may be produced by an immune response in suitable human or animal subjects after the injection of erythrocytes containing the appropriate antigen.

Academically, the blood groups are of importance in the elucidation of the antigenic structure of tissue cells. Application of this knowledge to blood transfusion therapy, to medico-legal problems concerning disputed paternity, blood stains, etc., and to anthropological and genetic research follows.

First, there is a genus specificity of blood. Thus the serum of human beings will agglutinate the erythrocytes of lower animals; likewise the serum of each genus of animal will agglutinate human erythrocytes and those of other animal genera.

Secondly, there is frequently a difference between the bloods of individuals belonging to the same species. Landsteiner[1] first demonstrated this in human beings. Our knowledge of human blood groups dates from this original observation.

Landsteiner and his pupils were able to divide human beings into four groups, the groups being dependent upon the presence in the red cells of either or both of two iso-agglutinogens A and B, or their absence. An international nomenclature has been adopted on this antigenic basis, and the groups are now designated AB, A, B and O (O signifying absence of both A and B). Naturally-occurring iso-agglutinins α (anti-A) and β (anti-B) are found in the sera according to Landsteiner's law: Those agglutinins, and only those, are present in the serum for which there is no corresponding agglutinogen in the red blood cells. The groups are thus AB (o), A (β), B (α) and O ($\alpha\beta$). Occasionally, however, defective groups are found, for example, A (o) or O (α). This is rare in adults, but not uncommon in infants.

Subdivision of two of the blood groups, A and AB, was made by von Dungern and Hirzfeld[2] in 1911. Serum from a group B person, absorbed with certain group A bloods, lost its power of agglutinating other samples of these bloods, but still agglutinated most other bloods of group A. This phenomenon is apparently due to the presence of two iso-agglutinins in group B sera (and group O sera), α which agglutinates all group A and AB erythrocytes, and α_1 which agglutinates most but not all A and AB red cells. The bloods agglutinated by α_1 are designated A_1 and A_1B: those agglutinated only by α are A_2 and A_2B. It has been suggested that the difference between A_1 and A_2 (and A_1B and A_2B) is merely quantitative. On the other hand, there is evidence of a qualitative difference in that individuals of groups A_2 and A_2B can be immunized against A_1 blood by repeated transfusions, or, in the case of women, by bearing a child whose blood contains the antigen A_1 (Wiener[3]). Group A bloods which react with the iso-agglutinin even more weakly than A_2 cells have been described and denoted as A_3 [4] and A_4 [5]. Sub-groups of the B agglutinogen have not been discovered. The iso-agglutinin α_1 can occur naturally in the sera of individuals of group A_2 and A_2B as well as those of group O and B. In the former cases it is usually active only in the cold below 37° C.

The agglutinogens A and B are inherited as mendelian dominants. Von Dungern and Hirzfeld[6], who first proved this, considered that the inheritance depended upon two independent pairs of allelomorphic genes. Bernstein[7] showed that this hypothesis did not fit the statistical findings, and suggested that inheritance depended upon three allelomorphic genes, A, B and R (or O). This theory is now generally accepted, with the rider that A_1, A_2, A_3 and A_4 form a series of allelomorphic genes which determine the A antigen.

Under von Dungern and Hirzfeld's theory, group O individuals would merely possess erythrocytes lacking A and B agglutinogens. With Bernstein's theory it might be expected that such cells would contain an agglutinogen "O". In point of fact, a water-soluble group-specific substance has been prepared from O cells (Hallauer[8]). Moreover, sera which will selectively agglutinate O cells are known (Schiff[9]). These anti-O sera are often designated as α_2 sera as they also agglutinate the majority of A_2 bloods, probably those of the heterozygous A_2O genotype. They occur in some natural animal sera (Schiff[9]), for example, bovine, some immune sera (Hooker and Anderson[10]) and as cold iso-agglutinins (Landsteiner and Levine[11]) in some group B, A_1 or A_1B human sera.

Agglutinable factors in human red cells, other than the agglutinogens A and B, have also been discovered. From certain immune rabbit sera, Landsteiner and Levine[12] obtained agglutinins for two factors which they called M and N. Human red cells can contain either or both of these agglutinogens (but *not* neither). Iso-agglutinins in human serum for M have been reported only in a very few instances, but no reliable report of an iso-agglutinin for N has appeared.

Friedenreich[13] has described a rare sub-group of N which has been termed N_2.

The M and N factors, as shown by Landsteiner and Levine[14], are inherited as mendelian dominants and their heredity depends upon a single pair of allelomorphic genes.

Other agglutinogens have also been reported from time to time. Of these the best-known is the factor P, which like the A substance probably represents a group of related agglutinogens[15]. The antibody can be obtained from normal and immune animal sera and occasionally in human sera (extra-agglutinin-1).

The group specific substances A and B have frequently been demonstrated in tissues other than erythrocytes (*cf.* Landsteiner and Levine[17]) by specific absorption and inhibition techniques. Schiff[18] extracted these substances in two forms, water-soluble and alcohol-soluble. Schiff[19] also found them in body fluids of certain subjects. Schiff and Sasaki[20] have called such people 'secretors': they have also found group O 'secretors'. The power of secretion is inherited as a mendelian dominant.

The M and N substances were for a long time thought to be confined to erythrocytes. They have lately been found in normal tissues by Kosjakov and Tribulev[21] and Boorman and Dodd[22], who also showed that the Rh substance (*vide infra*) was present in tissues. It would appear that M, N and Rh are relatively insoluble in water, as their presence in saliva is minimal.

The group specific antigens are, like other antigens, protein in nature. Haptenes derived from commercial pepsin, peptone, etc., however, have been

prepared which possess to a high degree the serological characteristics of the blood group *A* factor (Schiff and Weiler[23]) and the group *B* factor (Witebsky and Klendshoj[24]) without being themselves antigenic. They are polysaccharide complexes without protein. An artificial antigen of group *A* specificity has been prepared (Morgan[25]) by combining the *A* hapten with a protein.

Historically the latest and, from the transfusion therapy viewpoint, after *A* and *B* the most important blood group factor to be described, is *Rh*. It was first demonstrated (Landsteiner and Wiener[26]) by the use of an immune agglutinin produced in rabbits by injection of the blood of rhesus monkeys. The identity of this agglutinin with immune iso-agglutinins produced in man by repeated transfusions of blood of the correct *ABO* group[27] or by pregnancy[28,29] was soon demonstrated. In both instances persons whose erythrocytes lacked the *Rh* factor had been immunized by the *Rh* antigen. In the transfusion cases the blood transfused contained the *Rh* antigen in the erythrocytes; in the pregnancy cases it is necessary to postulate a leak of *Rh* antigen across the placental barrier from fœtus to mother.

In pregnancy, Levine, Katzin and Burnham[29] showed that this iso-immunization of the mother reflected on the newborn child, which manifested signs of 'erythroblastosis fœtalis' (hydrops fœtalis, icterus gravis neonatorum, congenital anæmia of the newborn). In view of the now accepted etiology of this condition, hæmolytic disease of the newborn is a preferable term. The immune iso-agglutinin passes back across the placenta and interacts with the fœtal erythrocytes and destroys them. Ottenberg[30] had previously suggested that this disease could be caused by iso-agglutinins α or β of the mother affecting her fœtus of group *A* or *B* respectively. The *ABO* blood groups, however, had no relation to the disease, and it is thought that the water-soluble group specific substances present in the body fluids of most *A* and *B* fœtuses would neutralize the offending agglutinin. Non-secretors would, on the other hand, be liable to be affected, and a few cases of hæmolytic disease of the newborn may be due to this cause. Immune iso-agglutinins, other than the typical *Rh*, could also produce it.

Suitable antibodies for the detection of the *Rh* factor are available by animal immunization—rabbit (Landsteiner and Wiener[26]) and guinea pig (Landsteiner and Wiener[31])—or they can be obtained from immunized human subjects. A special technique for their detection is required[32,33]. Different sera do not always give absolutely identical results, so for each *Rh* determination at least three sera should be used. In these circumstances it is found in the white populations of London[33] and New York[34] that approximately 85 per cent of persons are *Rh* positive and 15 per cent *Rh* negative.

It should be noted that, whereas 92 per cent of 153 mothers of infants with hæmolytic disease of the newborn were *Rh* negative (Levine, Burnham, Katzin and Vogel[35]), not all *Rh* negative mothers with *Rh* positive husbands (12 per cent of all matings) have affected infants. The *Rh* factor is inherited as a mendelian dominant (Landsteiner and Wiener[32]). If the father is heterozygous, *Rhrh*, half the offspring will be *Rh* negative and therefore unaffected. Even if the father be homozygous *RhRh*, although all the offspring will be *Rh* positive, one or more of the first children may be spared, because a greater degree of iso-immunizing stimulus may be necessary than is provided or the mother may be unduly resistant. In fact, it has been calculated (Javert[36]) that only 1 of every 438 newborn infants suffers from one or other form of the disease.

On the other hand, while 90 per cent approximately of mothers of infants with hæmolytic disease are *Rh* negative, the remainder are *Rh* positive. These subjects, like the *Rh* negative cases, show evidence of iso-immunization by their fœtus and provide interesting antibodies. One such antibody described by Levine, Javert and Katzin[37] and designated anti-*Hr* reacted mainly with *Rh* negative bloods, but also with some *Rh* positive bloods. A somewhat similar antibody has been denoted by Race and Taylor[38] as *St*. It agglutinated all *Rh* negative bloods and all heterozygous (*Rhrh*) bloods, but failed to agglutinate about 20 per cent of all bloods, and these must therefore be homozygous *RhRh*. Race, Taylor, Boorman and Dodd[39] report yet another antibody (*KJ*) which reacted with approximately 30 per cent of all bloods. This is similar to an antibody just reported by Wiener[40]. Race *et al.* suggest from the reactions of the *Rh*, *St* and *KJ* antibodies the probability of there being at least five allelomorphic genes: Rh_1, Rh_2, Rh_x, Rh_y and *rh*.

It will be remembered that not all anti-*Rh* sera give identical results. 84–85 per cent of positive reactions were obtained with standard animal serum (Landsteiner and Wiener[26]); 70 per cent with a human serum described by Wiener[28] and 86–87 per cent with most human sera (Levine *et al.*[35]). Wiener now calls the standard animal serum anti-*Rh*, the 70 percenter anti-Rh_1 and the 87 percenter anti-Rh'. This anti-Rh' is really a mixture of the two agglutinins anti-*Rh* and anti-Rh_1 and, by absorption with *Rh* positive bloods which do not react with anti-Rh_1 serum, the anti-Rh_1 agglutinin can be isolated. It was postulated (Wiener and Landsteiner[41]) that bloods which reacted with this anti-Rh_1 agglutinin belonged to type Rh_1, and those that reacted only with the standard guinea pig serum to type Rh_2. Up to this point, types Rh_1 and Rh_2 were analogous to group A_1 and A_2 bloods. Some rare bloods (Landsteiner and Wiener[32]), however, react with anti-Rh_1 (and therefore anti-Rh') but not with standard animal anti-*Rh*. The agglutinin, recently described by Wiener[40], reacting with 30–35 per cent of normal bloods, agglutinates bloods of so-called type Rh_2.

I have had the privilege of seeing a personal communication from Wiener, the manuscript of a paper to be published. The reactions of bloods to the agglutinins anti-*Rh*, anti-Rh_1, anti-Rh_2 and anti-Rh' are explained by postulating six allelic genes Rh_1, Rh_2, *Rh*, Rh', Rh'' and *rh*. Rh'' appears to be identical with the Rh_x of Race *et al.*, but Rh' appears to differ from Rh_y.

Race, Taylor, Cappell and McFarlane[42], by using an anti-Rh_1 serum in addition to anti-*Rh*, *St* and *KJ* sera, have confirmed the existence of the rare genes Rh' and *Rh* of Wiener, but suggest that the latter be termed Rh_0 as *Rh* has for so long had a wider meaning. The reactions of the various sera in identifying the genes can be best summarized as in the accompanying table.

By means of these four anti-sera, the genotypes of about 80 per cent of people can be determined if one ignores the rare genotypes. These latter can, however, often be detected by family studies.

The antibodies anti-Rh_1, *KJ* (anti-Rh_2), *St* and anti-*Rh* (animal) appear to be single antibodies and

Genes	Anti-sera			
	Rh	*St*	*KJ*	Rh_1
Rh_1	+	—	—	+
Rh_2	+	+	+	—
Rh_0	+	+	—	—
Rh'	—	—	—	+
Rh''	—	+	+	—
rh	—	+	—	—
Rh_y	?	—	+	?

not mixtures. It is tempting to postulate that these antibodies react specifically with partial antigens of the genes. Thus genes Rh_1, Rh_2 and Rh_0 would contain one common partial antigen; Rh_1 and Rh' another; Rh_2, Rh'' and Rh_y yet another; and Rh_2, Rh_0, Rh'' and rh a fourth. It is certain that the antibodies determine the presence of the genes wherever they occur: the various factors, therefore, appear to have equal dominance.

Although the final sorting out of the *Rh* complex and of the various anti-*Rh* agglutinins is not yet complete, it is clear that enormous strides have been made by increasing the identifiable types of human blood. Moreover, as stated by Wiener and Sonn[43], results appear to indicate that the *Rh* genes are located on a different pair of chromosomes from *ABO* genes. These in turn are located differently from *M* and *N* (Landsteiner and Levine[14]), so there are available at least four, including sex, of the twenty-four pairs of chromosomes for linkage studies in human genetics.

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UNCONSIDERED TRIFLES IN OUR DIET

VITAMIN CONTENT OF BEVERAGES

By SIR J. C. DRUMMOND and DR. T. MORAN

IT will be of interest to students of nutrition to point out some of the important results that have been obtained during the past twelve months from a re-examination of the contribution made to the nutritive value of our diet by common foods that are often ignored when evaluations are being made.

One of us (T. M.), in collaboration with Dr. J. B. Hutchinson[1], pointed out that water drunk in one form or another can add substantially to the daily calcium intake. An approximate estimate of that provided by drinking-water alone over the country as a whole was 75 mgm. a day. In some areas where the water is 'hard', the figure would be much larger. A modest pint of beer daily can provide about 70 mgm. Such quantities should not be ignored in calculating calcium intakes. Widdowson and McCance[2] have also stressed the importance of calcium from such sources, and have shown that contact of food with iron utensils often materially raises the quantity of iron in the diet.

Consideration of beer led to a re-investigation of its vitamin content. Since the original study by Harden and Zilva[3,4], it has been widely assumed that beers consumed in Great Britain have a vitamin content that is negligible. In the Medical Research Council Special Report on Vitamins[5] published in 1932, there is, however, a reference to an unpublished observation by Aykroyd that stout contains what was then known as "vitamin B_2", but no further information about this has been traced. In view of the properties of riboflavin and nicotinic acid, as contrasted with those of B_1 which is readily adsorbed by yeast, it appeared reasonable to expect that beer would contain a high proportion of the amounts of these two substances contained in the malt. This has proved to be the case. Both in the laboratories of the Cereals Research Station of the Ministry of Food and in Prof. R. H. Hopkins's Department at the University of Birmingham, riboflavin values for beers ranging from 0·5 to 1·7 μgm./c.c. have been found[6,7].

The riboflavin content of beer appears to be related to the strength of the brew. Samples of malt that we have examined have given values of 5·6 μgm./gm. (as against 2·5 μgm./gm. for barley), and on the basis of one pound of barley yielding three and a half pints of beer (corresponding roughly to present-day beer) it would follow that complete extraction of the riboflavin from the malt would give a beer of approximately 1·3 μgm./c.c. Complete extraction is unlikely, but it indicates the limiting riboflavin content. On the other hand, a sample of strong ale as supplied to Queen's College, Oxford, before the War gave a riboflavin figure of 3·9 μgm./c.c. What promised to be an even more interesting ale—a brew of 1798 to celebrate the battle of the Nile, kindly supplied to us by Mr. Julian Baker—gave the disappointing figure of 0·8 μgm./c.c. Very probably there had been some destruction of the vitamin during the intervening 150 years.

In these examinations the riboflavin values were determined by the microbiological technique[8], but a biological test on a sample of beer sent to Miss Copping

of the Lister Institute has given the value of 0·7 μgm./gm., or identical with that obtained microbiologically.

Beer is a good source not only of riboflavin but also of nicotinic acid (of the order of 15 μgm./c.c.), and it is also a reasonable assumption that it contains appreciable amounts of other recently identified nutrients, such as biotin, pantothenic acid and inositol. As regards the latter, there is appreciable destruction of phytic acid during germination, with a corresponding increase in the amount of inositol present. Thus in a sample of malted English wheat the phytate phosphorus was found to be 190 mgm. per cent as against an average figure of 270 mgm. before germination. In passing, we cannot refrain from directing attention to these new aspects of the nutritional merits of that popular lunch—bread, cheese and beer.

Brewed vinegars are also of interest in this connexion, and in the case of riboflavin have been found to have a content of approximately 0·7 μgm./c.c. Artificial vinegars, as would be expected from their composition, contain no nutrient materials.

The riboflavin content of beer seems to provide part of the explanation of the relative rarity in Great Britain of clear-cut symptoms of deficiency conditions. This is in striking contrast to what is seen in the United States and Canada. When Dr. V. P. Sydenstricker, one of the leading authorities on riboflavin and other deficiency conditions, was in England a short time ago, he was greatly impressed by the contrast but he found it difficult to give a plausible explanation. Beer drinking does not provide a complete answer, because there is no evidence that abstainers show a high incidence of signs of riboflavin deficiency. When one of us (J. C. D.) was recently in Washington, Dr. W. H. Sebrell informed him that he had obtained evidence of the presence of appreciable amounts of riboflavin in tea. This has been followed up with the following results, obtained on a few samples.

	μgm. per gm.
Tea	9·0
Coffee	1·7
Cocoa	2·7

These figures indicate that an amount of the order of 10 μgm. of riboflavin might be provided by a breakfast cup of tea. The daily quantity would certainly not be negligible in the case of the habitual tea drinker.

Following the same line of reasoning that led to the re-examination of beer, it was thought desirable to analyse commercial meat extracts. For a long time these have been dismissed by nutrition experts as of little or no value as foods. Lean meat is, however, a good source of nicotinic acid and contains an appreciable amount of riboflavin. Consideration of the methods of manufacturing meat extracts suggests that there would be considerable leaching out of these vitamins into the extract. This appears to be the case, since five well-known proprietary brands of meat extract gave riboflavin and nicotinic acid values in the ranges of 15·4–25·8 and 410–1,025 μgm./gm. respectively. A breakfast cup of these extracts would provide on the average 0·2 mgm. of riboflavin and 7 mgm. nicotinic acid. These quantities are by no means insignificant.

It is possible that the relatively high nicotinic acid content of meat extracts may prove to be related to their reputation as stimulants. The recent work of Frankau[9] is of interest in this connexion.

The experimental results reported above are only preliminary, but they are clearly of importance not only in connexion with an accurate assessment of our overall intake of nutrients but also in indicating fruitful lines of research in malting and food processing generally. It is certain that in brewing research in the future, stress will be laid on the conditions of malting and mashing that will give the maximum production of vitamins consistent with other requirements in the brewing process. Malted cereals would indeed appear to be deserving of the most careful study. Malt extracts may appear in a new light. Examination of a random concentrated sample gave a value indicating a riboflavin content of 8 μgm. per gm.; the nicotinic acid content will be correspondingly high. Malt products may, therefore, be of considerable importance as ingredients in bread and such products as breakfast foods, chick foods, etc.

Meat extracts are only half the story of meat processing; any concentration of vitamins in extracts means a corresponding poverty in corned beef. Likewise the inclusion before the completion of the process of any material extracted in the preliminary treatment of meat before drying is desirable not only on grounds of palatability but also of nutritive value.

This communication refers mainly to work being carried out at the Cereals Research Station of the Ministry of Food, St. Albans, particularly by Drs. E. C. Barton-Wright and R. G. Booth. Full details of this work will shortly be published.

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PRESERVATION OF FOODS BY DRYING

By DR FRANKLIN KIDD

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DRIED foods as a war development have been well advertised, particularly in the United States of America. With the exception of dried egg and dried skim milk ('household milk'), they have not, however, been on sale to the general public in Great Britain. The intelligent layman, therefore, in view of what he has been told through the Press about the exceptionally good quality of dried foods which modern science and technology have been able to achieve, although probably sceptical, would naturally like to try them.

An account appeared in NATURE of August 22, 1942, of a joint meeting of the Nutrition Society and of the Food Group of the Society of Chemical Industry at which the Department of Scientific and Industrial Research demonstrated the results achieved by British science during the War in improving the quality of dried foods. Dried vegetables—potato, cabbage, onions, swede—dried meat, dried egg, dried fish, dried milk and dried soups were served at lunch-time for appraisal by some hundreds of scientific and

technical workers present on that occasion. It was understood that the manufacture of products of corresponding quality was being actively developed.

Considerable interest is attached, therefore, to a recent lecture on the "Preservation of Foods by Drying" by Sir Joseph Barcroft, chairman of the Food Investigation Board of the Department of Scientific and Industrial Research, delivered at the Royal Institution on November 26.

Sir Joseph apologized at the outset for turning the lecture hall of the Royal Institution into something strongly resembling a kitchen, but aptly quoted from the original documents of the foundation, which described its objects as "for bettering the condition and increasing the comforts of the poor" by, among other things, "teaching . . . the application of science to the common purpose of life". There may be prejudice, he said, against dried foods. There is only one really adequate way to test dried foods, and that is to eat them. The *pièce de résistance* offered to the audience was a large shepherd's pie made on the demonstration bench from dried meat, dried potato, dried onion and dried milk, by Mrs. Edkins, reader in physiology in the University of London, and cooked during the lecture in Lady Dale's oven in the residency of the Director of the Institute. The audience accepted Sir Joseph's advice, and the observer records that nothing eventually remained but the dish.

In many instances acceptability to the palate has turned out to be a good criterion of nutritive value. In the case of milk and vegetables—and Sir Joseph thinks the same might be said of fish and meat—if the taste of the food is such as to make an appeal to the palate, the nutritive value of the food is largely unimpaired, and this to a physiologist with a nineteenth century background is not a little gratifying.

The drying of food aims at defeating both 'time' and 'space'. With regard to 'space', drying, combined with the process known as blocking, reduces the weight and volume of food to something like one eighth of the original. The actual reduction varies from food to food and is summarized in the accompanying table.

The same table shows how far drying combined with proper packaging and storage turns perishables into non-perishables, and so frees distribution from narrow and hampering time limits. But time is also defeated in another sense, that is, in the household, by the ready-to-eat or nearly ready-to-eat nature of the foods.

The world is shrinking. Each of us has less room and fewer hands at his disposal. Nowhere is this more important than in the kitchen. Silent forces are all the time impelling modern man to reduce his food,

Attainable saving calculated as between the most compact form and the form in which the commodity is most usually carried; and the *attainable storage time* after which the food is still in excellent condition, in gas-pack if necessary.

Food	Storage time	Saving per cent		Comparison with
		Weight	Bulk	
Meat	Indefinite	75	84	Frozen carcase, bone in
Fish	At least 1 year	90	85	Whole fish
Milk	Several years	87	89	Liquid milk
Egg	At least 1 year (temperature not higher than 60° F.)	80	90	Shell egg
Cabbage	2 years	95	87	Vegetables off farm
Potato	2 years	83	85	

while retaining to the full its palatability and nutritive value, to a form occupying the smallest possible space, having the least possible weight, keeping for the longest possible time and, above all, being as near as may be ready to serve and eat.

In the sense of being ready-to-eat and having a long storage-life dried foods are alternative to canned foods. With both, refrigeration is unnecessary. Canning has had most astonishing successes; it remains to be seen whether drying, under the acid test of use in war and afterwards in peace, will be able to emulate these successes.

During the lecture the following commodities were dealt with in turn, particular emphasis being placed on the properties enumerated above—retention of nutritive value and palatability, ease of preparation, saving in weight and space and storage life. The commodities were meat, fish, vegetables (various), eggs and milk. These commodities, with the exception of fish, are now all in production, specially tuned up in the light of recent discoveries, for the needs of the War. In all cases it was pointed out that drying as a process is nothing new to human art; what is new is the retention of quality: dried meat, among dried foods, is the latest arrival. Dried eggs, vegetables, and also dried milk have been known to commerce since the War of 1914–18.

Meat.—Fresh meat is cut into small pieces, and dried in a current of hot air, after being heated for a short time to 100° C. For the full flavour of the meat all the juices escaping in cooking must be returned prior to drying, and the temperature of the drying in warm air must be carefully controlled. These are the main provisos. The quality of the product afterwards reconstituted and cooked is little, if any, inferior to that of meat which has not been dried.

The product is a uniform one, and objective standards of quality can be set for various properties, flavour, consistency, nutritive value, fat content, freedom from bacterial contamination, etc.

Above all, dried meat, as to-day defined, is whole meat, nothing having been taken out in the process of preparation except water. The cooking is simply throwing the meat into hot water and cooking immediately, the time taken being that corresponding to the time taken for fresh meat. It is possible to make any dish which requires meat reduced to a mince or to small pieces.

Fish.—Fresh fish is dried in a very similar way to meat. In the case of fish, however, both the proteins and the fats are of a more delicate and labile nature. It had at first been thought that oily fish would present a difficult problem to the dehydrator, but experience has shown that this is not in fact so.

The flavour of fish is to some extent a post-mortem development. Sir Joseph described his experience at the Torry Research Station of the Department of Scientific and Industrial Research, of what he described as a spectrum of fish-cake flavours. Really fresh fish in many cases appears to have very little flavour at all. The fact that herring can be successfully dried may be of importance in the future to the herring industry.

Vegetables.—For drying of vegetables the principle of a pre-drying heat treatment is again used, the destruction of enzymes being of great importance. The savings in weight and bulk are usually most striking; for example, in the case of cabbage, weight off the farm 25lb., weight of dried material 1 lb. The demonstration exhibited a block of dried cabbage;

it was thrown into boiling water, swelled up and was completely cooked in twenty minutes.

There are special difficulties attached to the drying of potato which centre around the fact that the starch grains are gelatinized in the pre-drying heat treatment so that, if the cellulose cell wall enclosing them is broken, sticky consistency is produced on reconstitution with water.

On the subject of the retention of vitamins, particularly vitamin C in dried leafy vegetables, an experiment was quoted in which four hundred men were divided into two groups. Cabbage was served as part of a meal; one group had cabbage of good quality bought on the market and cooked in the ordinary way by professional cooks, the other group was given reconstituted dehydrated cabbage, prepared by the same cooks. In the result less cabbage was left on the plates of the latter group, and the intake vitamin value was higher in the case of the dried cabbage than in the case of the fresh cabbage.

Milk.—Milk has always presented a difficult problem of storage. The consumer has long known of sweetened condensed milk and unsweetened evaporated milk. In this case the weight of a quart is reduced from something like 41 oz. to 17 oz. When milk is dried the weight is further reduced to between 5 and 6 oz.

Dried milk can be made which on reconstitution is scarcely, if at all, distinguishable from fresh milk. Further, it can now be stored for periods of up to a year without noticeable change in palatability or nutritive value. Sir Joseph stressed the fact that Britain is a milk-producing country, and that one of our problems had always been that of dealing with the surplus spring and summer milk which is produced in the first flush of the growth of grass. He thinks it has now become possible for the consumer to use the excess of summer milk the following winter.

General Principles.—The general principles whereby high quality is obtained in the drying of food, and the relation between drying and preservation by cold storage in the frozen condition, were briefly sketched. A process of drying foods which has not yet been developed on the commercial scale was referred to, namely, that of evaporating the ice from frozen foods without thawing—the process which is, in fact, now being used for the storage of human plasma and sera for transfusion.

One of the main principles in successful drying is the destruction of enzyme systems by pre-heat treatment; the other is the protection of the dried products from atmospheric humidity and oxygen. Careful control of temperature is always necessary.

Blocking.—On the question of blocking, it was pointed out that in the case of meat the latest development, that is, blocking, has been adopted from the outset. Besides the further saving in volume, blocking has the effect of eliminating oxygen from the pack, which in the case of meat is a hermetically sealed tin. It retards penetration of oxygen if, as in the case of certain other foods, hermetically sealed cans are not used.

Blocks of carrot and cabbage were demonstrated, and it was understood that while most of the preliminary work and development has now been done, blocking has not yet been practised on a large commercial scale except in the case of meat. In the case of dried vegetables which pack very loosely, blocking effects a big further saving in volume.

In the course of his lecture Sir Joseph said that, while he has been for the most part presenting work carried out by the Department of Scientific and Industrial Research on the advice of the Food Investigation Board, and principally at the Low Temperature Research Station, Cambridge, he wanted to say that there has been fruitful and active collaboration both with the Agricultural Research Council and the Medical Research Council throughout. The Agricultural Research Council is especially concerned with milk, and the Medical Research Council with the retention of nutritive value.

In the case of all the newly developed foods of high quality, he stressed the fact that this quality is now scientifically ascertainable and statable in objective terms so that a definite standard could be set and insisted on, and the consumer, if necessary, could be protected against exploitation. The principal properties tested at present are palatability, nutritive value and storage life. New techniques are being worked out for assaying palatability. The great development during the last three years of spray-dried egg in the United States and Canada, due to their genius for mass production, has all been subjected to rigid quality tests based on the results of researches in which Great Britain had been to a considerable extent the pioneer.

OBITUARY

Sir Robert Alexander Falconer, K.C.M.G.

ON November 8, 1943, Sir Robert Falconer was buried from the Convocation Hall of the University of Toronto, over the destinies of which he had presided for twenty-five years. An attack of coronary thrombosis in 1930 impaired his health and compelled him to retire in 1932. His father, a Canadian of Scottish ancestry, was a Presbyterian missionary for some years in Trinidad. Here his son obtained his early education; and from the West Indies won a Gilchrist Scholarship which enabled him to attend the University of Edinburgh. In those days Butcher and Sellar lectured in classics; A. S. Pringle-Pattison in philosophy; David Masson in English literature; and Chrystal and P. G. Tait in mathematics and natural philosophy. Young Falconer graduated with honours in classics and philosophy, and proceeded to the study of theology in Edinburgh, Leipzig, Berlin (under Harnack) and Marburg. He returned to Canada to become at first professor of New Testament Greek, and then principal, of Pine Hill Theological College, Halifax, Nova Scotia. Here he remained until 1907.

In that year Falconer was chosen president of the University of Toronto, which had recently been reorganized by a Royal Commission. This post in a university, which on the arts side included several federated denominational universities and colleges, required great tact, broad interests, good administrative powers and the ability to bring into happy co-operation conflicting interests. This task Sir Robert successfully accomplished. As president his first duty was to administer the new constitution in a period of national expansion. The University grew in numbers, buildings, faculties and departments. The growing needs of Canada were met by increased facilities. After the interval of the War of 1914–18, a new and rapid development followed. The president was quick to recognize and to anticipate public demands for varied types of training at the university level. When he retired in 1932, the University com-

prised the Faculties of Arts, Medicine, Engineering, Forestry, Household Science, Education, Music, Dentistry, and a promising School of Graduate Studies. In fact, it had passed from the 'college' to the 'university' stage.

While always a champion of humanistic studies, Sir Robert had keen sympathy with the scientific side of university work. Indeed he had a singularly well-balanced and catholic mind. A very great advance was made in medicine, until the Faculty of Medicine became one of the chief medical schools of America. The new Toronto General Hospital, with more than 1,200 beds, became the teaching hospital of the University, and clinical services were secured also in the Hospital for Sick Children, St. Michael's and the Western Hospitals. The gift of the Connaught Laboratories by Sir Albert Gooderham provided for the manufacture of biological products; and all profits therefrom were devoted to medical research, particularly in the field of preventive medicine. The discovery of insulin in 1922, by Sir Frederick Banting, gave an enormous impetus to scientific investigation in general. Banting became the first incumbent of the Banting and Best chair of medical research, and, on his tragic death in an air crash, his chief collaborator in the insulin investigations, Dr. Charles H. Best, succeeded him. All the royalties from the sale of insulin went into medical research. The income of the Banting Foundation (about 750,000 dollars), raised to commemorate Banting's work, was devoted to the same purpose. The Rockefeller Foundation established and endowed a School of Hygiene, which has become a centre of teaching and research in preventive medicine throughout the whole Dominion. The great physics laboratory under the leadership of the late Sir John McLennan was a hive of investigation in low-temperature experiments, in the liquefying of helium, in spectroscopy. These are but examples of the general scientific life of the University. Indeed, the spirit of research permeated every part of the University, more extensively in the domain of the physical sciences but appreciably also in the humanities and the social sciences. Of all these developments Sir Robert might truthfully have said, *quorum magna pars fui*.

Although the chief support of the University of Toronto is the annual Government grant, Sir Robert Falconer found that private benefactions were not restrained. The chief of these was the princely gift of Hart House by the Massey Foundation (the inspiring genius of which was the Right Honourable Vincent Massey, now Canadian High Commissioner in England). This is a superb stone building, in collegiate Gothic style, which serves as a social centre for men from the colleges, faculties and departments of this rather variegated institution. Another gift from the same family was the building to house the Faculty of Household Science, the donor of which was Mrs. Massey Treble, aunt of Mr. Vincent Massey.

After Sir Robert Falconer's retirement from the presidency, by careful watching over his health, he was able to do much in fields which were always of special interest to him. He was president of the Royal Society of Canada, of the Royal Canadian Institute (for popularizing scientific discoveries), of the League of Nations Society, and of the Red Cross. His interest in international affairs was perpetuated by the establishment of a lectureship which bears his name; and under which the first lecturers have been Lord Baldwin and Lord Hailey.

Always dignified, sometimes austere yet kindly withal, of judicial temperament, and of deep religious convictions, Sir Robert Falconer spent a long life of high endeavour and great accomplishment. He served well the University he loved, the Dominion of Canada and the whole of the British Empire, in the beneficent mission of which he firmly believed.

H. J. CODY.

NEWS and VIEWS

University Chair in Forestry at Bangor

THE creation of a chair of forestry at the University College of North Wales at Bangor has been recently announced, and Mr. Thomas Thomson, lecturer and head of the Forestry Department there, has been appointed as the first occupant. A lecturer in forestry was appointed in the Department of Agriculture at Bangor so long ago as 1904, Mr. Fraser Story being the first incumbent. A few years later a separate Forestry Department was created, giving full degree courses. In 1912 Mr. Thomson was appointed to the Department as assistant lecturer to Fraser Story. Two years later the Department was temporarily closed down, and the two members of the staff transferred to the Timber Supplies Department. In 1919 Fraser Story resigned, being afterwards appointed to the Forestry Commission. Thomson then held sole charge of the Department until, in 1932–33, an assistant lecturer in forestry was appointed. The head of the Department had always been a member of the Senate and Faculty. In addition to his work in the Department, Prof. Thomson has done a good deal of advisory work in North Wales, and he is the author of a translation of Busgen's "Structure and Life of Forest Trees", and, in conjunction with Mr. Jerram, lecturer in the Department, of a small book entitled, "An Outline of Forestry".

Future of Pharmacy

AN address on "The Natural History and Chemistry of Drugs" was given to the Pharmaceutical Society of Great Britain by Sir Henry Dale, president of the Royal Society, on January 13, on the occasion of the award to him of the Hanbury Memorial Medal. In the course of his address, Sir Henry considered the changes in the conceptions of drugs which current advances in the medical sciences and the changing objective of therapeutics must entail, and raised the question of the future function of pharmacy under the conditions which can be foreseen. In 1932, the "British Pharmacopœia" included representative examples of the vitamins, the hormones and the immunological products, as well as some of the earlier synthetic agents of specific chemicotherapy. This represented not merely the introduction of new remedies more effective for the old purposes, but a change in the accepted aim of medicinal treatment from the relief of symptoms to the removal or prevention of the cause of disease. This will lead in due course to changes in the pharmacist's interests. Eventually the preparation of the remedies required by progressive therapeutics will fall into the hands of scientific large-scale manufacture; and the individual pharmacist will presumably become little more than an intelligent retail distributor of ready-made and centrally standardized products.

Important changes in the organization of medical practice will be necessary if the great advances which research is producing in methods of diagnosis and treatment are to be made properly available for the ordinary citizen in his home. Unless the medical practitioner is to become a mere sorting machine to secure the transfer to hospital of every case requiring serious scientific attention, he will require the services of an organization such as the common laboratory facilities which any modern hospital affords. This would require a very large number of new laboratory centres with well-trained men, and the profession of pharmacy should be interested. Some of the procedures commonly regarded as biochemical and now used in the control of some modern medication are nothing but applications to a biological vehicle, such as blood or urine, of pharmaceutical methods of assay, such as students of pharmacy still learn. Sir Henry Dale therefore suggested that "the nearest equivalent to the expert co-operation which was afforded by the work of Daniel Hanbury and the pharmacists of that old tradition to the medicinal treatment of their own days may be found under modern conditions in the aid which diagnosis and treatment still increasingly need from the laboratory".

British Coal Utilization Research Association

THE annual meeting of the British Coal Utilisation Research Association was held in London on December 15, 1943. In his presidential address, Sir Evan Williams, Bart., gave an account of the present attainments and plans of the Association, now the largest co-operative industrial research enterprise in Great Britain. The original grant by the coal owners has been doubled. It is planned to extend the research work to include the production of liquid fuels and chemical products, and for this the colliery owners are contributing in the next two or three years a fund up to £500,000. It is hoped to improve on the Fischer-Tropsch process. Efforts to increase the efficiency of coal utilization are already an important branch of the Association's work and, while bringing aid to the consumer, are anticipated to lead to a greater demand for coal. Prominent in this direction is the attention paid to the design of the open fire, for which great improvement in heat efficiency and convenience is claimed. It is a matter of experience that the greatest obstacle to technical progress is often the transference of new laboratory discoveries to commercial success. Recognizing this, the Association is planning to undertake the trial manufacture of new appliances and the pilot plant operation of new processes. For this purpose, a large site for a research station has been acquired at Leatherhead. From this, it will be seen that a scheme is envisaged on a scale worthy of so great a national problem.

It may be questioned, however, whether the ambition to increase the demand for coal is a proper ideal. In this connexion the statement that the Association aims at increasing the consumption of coal—the most precious but waning asset of Great Britain—reads curiously. War-time experience raises a question as to whether we should not be developing alternative sources of power while conserving coal for use as fuel and sources of chemical products. Moreover, it should not be forgotten that research has been and is being prosecuted by the fuel industries, and that its progress will be determined, not merely by the expenditure of money, but by the supply of effective staff.

Imperial College and 'M.I.T.'

PROF. R. V. SOUTHWELL, rector of the Imperial College of Science and Technology, London, has announced in a letter in *The Times* that the College has come to an arrangement with the Massachusetts Institute of Technology whereby the two institutions will maintain, after the War, a regular interchange of staff and postgraduate students. The Massachusetts Institute of Technology, or more briefly, 'M.I.T.', has a history of eighty years of activity which has made it known throughout the world as a centre for postgraduate instruction and research in science and technology. Indeed, it was planned specifically for this purpose, its charter stating among its purposes "the advancement, development and practical applications of science in connection with arts, agriculture, manufactures and commerce". The Imperial College in London has a very different history. It arose, as is often the way in Great Britain, by the fusion of three existing colleges, the Royal College of Science, the Royal School of Mines, and the City and Guilds College, which from being physically neighbours became associated by Royal Charter in 1907. The College provides advanced specialized instruction and equipment in various branches of science, especially in its application to industry, and is administered by a board including representatives of the Crown, the Indian Empire, the self-governing Dominions, the Board of Education, the London County Council, the Royal Society and other bodies. During the War, there has been gradually increasing interchange of information on scientific and technical developments between Great Britain and the United States, and the association of these two colleges in the intimate relationship involved in exchange of staff and students is a guarantee that Anglo-American collaboration in the fields of science and technology is to continue.

Work of Benjamin Huntsman

AT a meeting of the Newcomen Society held on January 12 at the Iron and Steel Institute, Mr. E. W. Hulme read a paper "On the Pedigree and Career of Benjamin Huntsman, Inventor in Europe of Crucible Steel". Various fictitious accounts have been given of Huntsman and his invention, and it has been said that he was the son of indigent parents. As a matter of fact he came of the Quaker family of Huntsman of Epworth, Lincolnshire, well known for their good social standing. Benjamin began his career as a watch-maker's apprentice, and he remained at this craft all his life. He set up for himself at Doncaster, about 1740–44 removed to Handsworth, Sheffield, and in 1770 to Attercliffe, where the firm he founded still is active. He died at Attercliffe in 1776. It was to remedy the defective working of watch-springs that he was led to invent a new kind of steel, and there is ample proof of his great metallurgical and mechanical skill. Cast steel made in a crucible heated in a charcoal fire supplied with a forced draught is an invention of unknown antiquity. It was known as "Wootz" steel, and was exported from southern India to Damascus, where it was called 'Damascus' steel. It was this steel Huntsman set himself to imitate, but the crux of the invention was how to make crucibles that would stand high temperatures. Of Huntsman's character little is known with certainty. At one time, it was suggested that he should be put up for election to the Royal Society, but he declined the honour.

Fungi for Food

THE larger fungi contain appreciable amounts of protein, carbohydrates and vitamins suitable for human nutrition, but their unique flavours, compounded from a plethora of little-known substances, make an even greater contribution to gastronomic variety. Dr. J. Ramsbottom is trying to stimulate interest in a wider use of our native fungi, and in a recent short paper (*J. Roy. Hort, Soc.*, 68, Pt. 10; Oct. 1943) describes fourteen species which might supplement the mushroom in our diet. The chanterelle (*Cantharellus cibarius*), blewits (*Tricholoma personatum* and the related *T. nudum*) and the morel (*Morchella esculenta*) may already be known to some connoisseurs, but the others are no less tasty. The great need appears to be for inspiration in methods of cooking. Dr. Ramsbottom has made a start in this direction, but much yet remains to be accomplished. The common *Hygrophorus pratensis*, for example, though palatable in the raw state, can be converted into a tough leathery mass by incorrect culinary preparation. All the species mentioned in Dr. Ramsbottom's paper, however, can be trusted to yield their flavour, and stimulate the palate, even with ordinary methods of cooking.

Poisonous Gases in the Exhaust of Diesel Engines

DR. ENRIQUE CASTELLANO has an article on this subject in *Publicaciones de la Facultad de Ciencias Fisicomatematicas, Universidad Nacional de la Plata* (June 1943), in which he gives a full account of his experiments to discover if pernicious effects are produced in the driver's cabin by the fumes from the exhaust. A description is given of the methods adopted for determining the amount of each of the gases ejected, and the results are summarized at the end of the paper. Comparing the figures with those for the concentration dangerous to human life for each gas, it is interesting to notice that there is a large margin in the concentration of carbon monoxide —a gas which is generally believed to be extremely dangerous in the fumes from the exhaust.

	Concentration in parts per thousand in Diesel exhaust	Maximum safe concentration
Carbon dioxide	0·77	5·5
Carbon monoxide	0·0046	0·05
Hydrogen sulphide	0·000058	0·02
Sulphur dioxide, etc.	0·00015	0·01
Oxides of nitrogen	0·0020	0·01
Aldehydes	0·000046 gm./m.^{3}	0·02 gm./m.^{3}
Carbon	0·0023	
Oils, hydrocarbons not burnt or only partly burnt	0·00046	

From these figures it appears that the concentration of gases in the cabin is far below that which is usually considered detrimental to life. In the case of the hydrocarbons and carbon, it is impossible to draw any definite conclusions, because no figures are available regarding the concentrations which are considered dangerous to human life.

Portuguese Navigators

REFERRING to the article in NATURE of November 27 on "Anglo-Portuguese Scientific Relations", Mr. Arthur J. Hughes, of Messrs. Henry Hughes and Son, Ltd., nautical and aeronautical instrument manufacturers, remarks that "the work of Prince Henry the Navigator is still being gloriously continued in Portugal. Perhaps two of the greatest navigators of the air were the late Comdr. Cabral and Admiral Coutinho, of the Portuguese Navy, who crossed the Atlantic in 1922, on the way making a brilliant landing at the Azores by close and accurate navigation. There is in Brazil to-day a great descendant of the Portuguese, Capt. Radler Acquino, who is an acknowledged expert on all methods of modern navigation. He has just published a new book of tables in Portuguese, which would delight the heart of Henry the Navigator by their simplicity. There are also tables in navigation by distinguished Portuguese navigators, Newton and Pinto, in 1930 and 1933, and there is a very close scientific connexion in nautical science and hydrography between the Portuguese and British Navies."

Newton's Verses

NEWTON's habit of transcribing passages from the writings of others has misled some writers into regarding him as something of an alchemist. Prof. E. N. da C. Andrade now concludes (*Proc. Phys. Soc.*, **55**, 426; 1943) that the same habit has misled those authors who have regarded Newton as something of a poet. When he was a boy, Newton apparently drew a picture of Charles I and wrote some verses underneath. Mrs. Vincent of Grantham repeated them by memory to Stukeley, who adds, "She fancyed, and aver'd it that he composed them himself. I rather suppose he copyed the print prefixed to the *Eikon basilice*". Prof. Andrade reproduces the verses from the "Eikon basilice". Comparison of the two versions suggests that Newton omitted the last six lines in transcribing the verses, and that Mrs. Vincent may have recollected imperfectly what he wrote. A recent biographer wrote: "These are very good verses in the fashion of the day to be written by a boy of his age". Prof. Andrade concludes: "The Eikon basilice verses, though poor and conventional, show some slight feeling for poetry. I do not think that Newton can ever have written anything even as good as this."

Comet Peltier-Kellaway

COMET PELTIER-KELLAWAY was discovered by Peltier on December 17 and independently by G. F. Kellaway, West Coker, Somerset, on December 19. Its magnitude at the time of discovery was about 6. It made its closest approach to the sun on January 19 and is becoming fainter.

Announcements

PROF. NIELS BOHR, professor of theoretical physics, University of Copenhagen, has been elected a member of the Athenæum under Rule II of the club, which permits the "annual election by the committee of a certain number of persons of distinguished eminence in science, literature, or the arts, or for their public services".

DR. R. E. MORTIMER WHEELER, director of the Society of Antiquaries and keeper of the London Museum, has been appointed director-general of archæology in India.

IT is announced that the ship-building industry in Great Britain, after consultation with the Department of Scientific and Industrial Research and the Admiralty, has decided to establish a British Shipbuilding Research Association, to develop all branches of research associated with ship-building, marine engineering and ship repairing.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Mutation and the Rhesus Reaction

IN his interesting letter[1] on genetics of the *Rh* antigen in man, Prof. L. T. Hogben advances two hypotheses. The first is that the frequency of the *rh* gene, determining the absence of the antigen, is approximately constant from one generation to another in human populations. The second is that this constancy is due to the formation of new *rh* genes by mutation, at a rate which replaces those eliminated by the deaths of heterozygotes from erythroblastosis fœtalis. Thus such populations as those of England and the United States are thought to be in equilibrium.

Prof. Hogben does not refer to the earlier work of Wiener[2] and Haldane[3] on this question, perhaps because the latter at least requires some revision in the light of later observations. Neither Wiener nor Haldane believed that the present frequency of the *rh* gene was stable, and they ascribed it to the formation of the Western European people by (geologically) recent crossing between a race in which the *rh* gene was very rare, as it is[4] in American Indians, and one in which it was very common. Haldane calculated that selection at its present intensity would reduce the frequency of *Rh*-negative individuals from its present mean American value of 14 to 1 per cent in about six hundred generations.

Whether or not the theory of racial crossing is accepted, there is a sound reason for rejecting Prof. Hogben's theory, namely, that the equilibrium which he postulates would be unstable. Let t be the time measured in generations, p the frequency of the *rh* gene, $1 - k$ the ratio of the mean viability of *Rh rh* children of *rh rh* mothers to that of other babies, and μ the frequency with which *Rh* (or a group of dominant allelomorphs) mutates to *rh* per generation. Then it follows from the argument given by Haldane[3] that

$$\frac{dp}{dt} = \mu(1-p) - kp^2(1-p)(\tfrac{1}{2} - p) + O(k^2).$$

Hence at equilibrium $\mu = kp^2(\frac{1}{2} - p)$. Among American whites $p = 0{\cdot}39$, so if they are in equilibrium $\mu = 0{\cdot}016731k$. If p is slightly increased, say, to $0{\cdot}40$, $\frac{dp}{dt} = +\,0{\cdot}0004386k$, so it will tend to increase further. If it is slightly diminished to $0{\cdot}38$, $\frac{dp}{dt} = -\,0{\cdot}000370k$, so it will tend to diminish further. If $\mu = 0{\cdot}016731k$ the only stable equilibria are given by $p = 1$ and $p = 0{\cdot}27$.

In general, the condition for stability is that $\frac{d}{dp}\left(\frac{dp}{dt}\right)$ should be negative in the neighbourhood of the equilibrium. It can readily be shown that this is only possible, whatever the mutation-rate, if $p < 1/3$. The existence of unstable equilibria between selection and mutation was pointed out by Haldane[5], and it is always desirable to investigate the stability of postulated equilibria of this kind.

While it would seem that Prof. Hogben's theory must be rejected, I do not wish to suggest that my own should therefore be accepted. Its acceptance must depend, among other things, on research into the frequency of different allelomorphs at the *Rh* locus in various populations, and I fully support Prof. Hogben's plea for more such research. This is particularly desirable in Asiatic populations where, if anywhere, a high frequency of *rh* might be expected.

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[1] Hogben, NATURE, 152, 721 (1943).
[2] Wiener, *Science*, 96, 407 (1942).
[3] Haldane, *Ann. Eug.*, 11, 333 (1942).
[4] Landsteiner, Wiener and Matson, *J. Exp. Med.*, 76, 73 (1942).
[5] Haldane, *Proc. Camb. Phil. Soc.*, 23, 838 (1927).

IN NATURE of December 18, Prof. L. Hogben has discussed the question of gene equilibrium in the Rhesus blood-group factor, and draws the conclusion that a mutation-rate from Rhesus-positive to Rhesus-negative genes of quite unprecedented magnitude can be inferred from what is at present known of the genetic situation and the medical facts.

With the importance of obtaining direct and unbiased data of the vital statistics of marriages between different genotypes we are in most hearty agreement; and, indeed, have already taken preliminary steps toward a direct ascertainment of these factors. The situation in some respects, however, does not appear to us to have been correctly stated by Prof. Hogben; in particular, we would dissociate ourselves from the statement that "Levine's hypothesis postulates a form of adverse selection. . . ." It appears to us, on the contrary, that the evidence for Levine's theory of the causation of hæmolytic disease of the newborn is completely independent of any such postulate, and would be equally convincing whether there is or is not any such selective influence at work. It would also be wrong to infer a selective elimination of the rarer gene from a demonstrable elimination of heterozygotes, unless we knew, as we do not know, that fertility is not concurrently affected.

Finally, we do not think that Prof. Hogben's theory of an abnormal mutation-rate gains any confirmation from the rather extensive system of multiple allelomorphs of the Rhesus factor recently demonstrated at the Galton Laboratory Serum Unit and elsewhere. Speaking of his mutation-rate, Hogben says: "on the other hand, its value is not inordinately high if we interpret μ to signify the rate of mutation at the *Rh* locus from *any one of a series* of 5 or more dominant alleles". Of the seven allelomorphs we now postulate, not more than four are Rhesus-positive, while three are Rhesus-negative. Moreover, we do not see that the mutation theory is aided by the supposition that the hypothetical mutation is derived from any one rather than equally from all of the possible sources.

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The Human Side of Anthropology

THE recent editorial in NATURE[1] made out a very strong case for the importance of the social sciences as a scientific contribution to the welfare of the community; and in the same issue, Prof. Le Gros Clark directed attention to some of the rich and interesting

fields open to the exploitation of the 'physical anthropologists'. As the editorial pointed out, the scope and power of non-experimental and statistical methods of analysis are becoming more widely appreciated—a movement of opinion which will undoubtedly have been encouraged by the experience of the application of science to war. It is probable, therefore, that most men of science will be disposed to wish the social scientific workers well in their endeavours to win a more favourable place in the sun.

One is also grateful for the strong emphasis which the British Association Committee on Scientific Research on Human Institutions, to which the editorial refers, has placed on the necessity for an empirical and where possible a quantitative approach. Perhaps one can recognize here the hand of Prof. L. Hogben, whose spirited invective against the more fanciful constructs of deductive theorists has so often amused and stimulated his readers in the past. But while in no way calling this emphasis in question, I wish to suggest that there is a danger that this attitude, desirable in itself, may lead to the neglect of one very important side of anthropological inquiry—indeed, the one branch of the subject which deals with those aspects of man in which he differs most completely from other animals. Human birth- and death-rates can be studied with the same theoretical apparatus as those of Drosophila; human nutrition is a problem very similar to that solved by the directors of the Zoo; 'social security', in the sense of support during illness and after retirement, we already provide for some of our domestic animals. The characteristically human is to be found in the general field of education and social life—two mutually dependent functions which together bring it about that man's evolutionary advance is mediated by processes quite unlike those found anywhere else in the animal kingdom. The study of the interrelations between the upbringing of children and the structure of the society into which they are being initiated is in its infancy, but it has been begun, particularly by American scientific workers. The Lynds and some of the Chicago school touched on it, and it has been considerably developed by authors such as Benedict, Mead and Bateson, on the sociological side, while the work of many psychologists impinges on it at another angle.

Investigations in this field have an essential part to play in solving the problems of reconstruction facing us. For example, we need to know how far it is true, and for what reasons, that the concept of 'social security' has a great appeal to British people, while to many Americans it seems to cloak the apathy of a nation which has lost its saving faith in the virtues of 'rugged individualism'. Again, we hear much of the need for the re-education of Germany; but have we any clear idea of the features in German social life which produce the attitude of unquestioning subordination to superiors, and callous domination over inferiors, that we wish to eradicate? A recent example of how such questions can be tackled is provided by the important book of Bateson and Mead on "Balinese Character" and Mead's later and more popular "—And Keep Your Powder Dry"[2].

It is much to be hoped that such studies will be encouraged in any general policy for the development of social sciences in Great Britain. The infant science needs protection, on one hand against the view that such subjects cannot be made amenable to scientific study, and on the other against the ideological contention that social characteristics spring so directly from the economic set-up that there is nothing to be gained by a close study of them.

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[1] NATURE, 152, 669 (1943).
[2] "Balinese Character", by G. Bateson and M. Mead (New York Acad. Sci., 1943). "And Keep Your Powder Dry", by M. Mead (New York, 1943); see NATURE, 151, 405 (1943).

Activity of Purified Carbonic Anhydrase

WE have shown previously that carbonic anhydrase is a zinc-protein compound[1,2] and this was confirmed by other workers[3,4]. That the catalytic activity of carbonic anhydrase, unlike the physiological activity of insulin, depends on the presence of zinc in its molecule is strongly supported by the following considerations. (1) An instantaneous, strong and perfectly reversible inhibition of carbonic anhydrase by very small concentrations of potassium cyanide, hydrogen sulphide and sodium azide which react in this way only with metals. (2) The presence of high concentrations of zinc in purified enzyme preparations obtained by different methods and from different materials. (3) The proportionality between the zinc content of different fractions and their catalytic activity. (4) The absence of other metals from purified enzyme preparations.

Our purest enzyme preparation, having approximately 2,220 enzyme units per mgm. dry weight[2], was a colourless protein containing 14·8 per cent nitrogen and 0·3–0·33 per cent zinc. As this preparation appeared homogeneous in the Tiselius apparatus[2], and in an ultracentrifuge[5], it may be considered as either pure or almost pure enzyme. It was therefore a matter of some surprise to us when Scott and Mendive[4] announced that they had obtained an enzyme preparation containing 9,000–10,000 enzyme units per mgm. dry weight with a zinc content of 0·2–0·23 per cent. Their preparations appeared, therefore, to be 4–4·5 times more active than our purest preparation. However, a careful examination of their methods of estimation of enzyme activity revealed that the high value obtained by them is only an apparent one. Their estimations were carried out in the presence of a small amount of peptone; this has the property not only of stabilizing the purified enzyme, which is very fragile in dilute solutions, but also of doubling the activity of freshly diluted purified enzyme. This factor alone would make their activity values appear at least double those given in our paper. On the other hand, peptone produces no activating effect on the carbonic anhydrase in laked blood corpuscles, which is probably due to the high concentration of proteins already available. Yet, the activity of laked corpuscles estimated by these workers was about twice as high as the value found by us. Thus in corpuscles of 18 l. of blood they found about 71 million enzyme units, whereas the same amount of blood according to our estimation contained only 37 million enzyme units.

As this discrepancy cannot be ascribed either to the possible use of peptone by these workers or to the differences in enzyme content of ox blood in Great Britain and in Canada, it can only be due to a difference in the values of the enzyme units used by us and by these workers. In this way, Scott and Mendive[4] have introduced a second factor which doubles the activity of their enzyme preparations.

The numerical value expressing the activity of their enzyme was therefore raised artificially at least four times. In other words, the activity of their best enzyme preparation expressed in our enzyme units and estimated by our method will be approximately the same as that of our pure preparation.

The comparatively low zinc content found by these workers may be due to the method of Sahyum and Feldkamp which they used and which, unlike the dithizone method used by us, requires larger amounts of zinc and invariably gives low zinc values. Their exceptionally high yield, of up to 50 per cent of purified enzyme compared with our maximum yield of 30 per cent, can only be explained by the effect of peptone which, as they have shown, doubles the activity of purified enzyme preparations.

As to the crystals of carbonic anhydrase obtained by Scott and Fisher[6], the thin plates described and photographed by them as crystals of ammonium-carbonic anhydrase show scarcely any crystalline structure and were often observed by us during precipitation of the purified enzyme. On the other hand, the crystals of alleged compounds of carbonic anhydrase with piperidine, *iso*amylamine and *n*-amylamine described by these workers have no relationship to the enzyme. In fact, these crystals, as shown by Scott and Fisher[6], are completely devoid of catalytic activity. They are obviously the crystals of salts of these bases mixed with denatured protein of carbonic anhydrase, which protects them from evaporation. They can even be obtained with gelatin instead of carbonic anhydrase.

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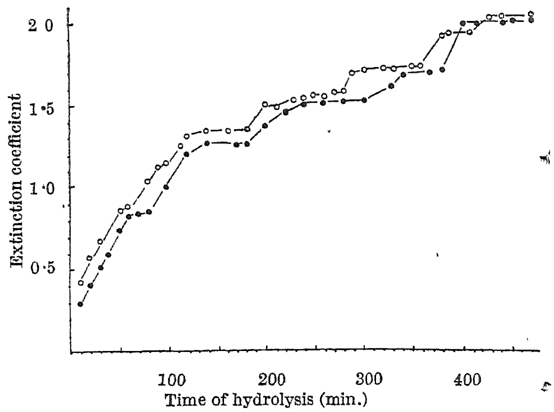
[1] Keilin, D., and Mann, T., NATURE, **144**, 442 (1939).
[2] Keilin, D., and Mann, T., *Biochem. J.*, **34**, 1163 (1940).
[3] Hove, E., Elvehjem, C. A., and Hart, E. B., *J. Biol. Chem.*, **136**, 425 (1940).
[4] Scott, D. A., and Mendive, J. R., *J. Biol. Chem.*, **139**, 661 (1940) and **140**, 445 (1941).
[5] Eirich, F. R., and Rideal, E. K., NATURE, **146**, 541 (1940).
[6] Scott, D. A., and Fisher, A. M., *J. Biol. Chem.*, **144**, 371 (1942).

Slow Protein Hydrolysis in the Presence of 2,4-Dinitrophenylhydrazine

IN our search for reactive keto groups in the protein molecule, we found that 2,4-dinitrophenylhydrazine could be coupled with the protein framework to a surprisingly great extent (one molecule of the hydrazine to about six amino-acid residues). In a typical experiment, 100 gm. casein ("nach Hammarsten") was boiled with 1,000 c.c. 0·3 *N* hydrochloric acid and 10 gm. 2,4-dinitrophenylhydrazine. From time to time 4 c.c. samples of the mixture were removed, precipitated with 5 c.c. 10 per cent trichloroacetic acid, centrifuged, and 2 c.c. of the supernatant liquid and the whole of the precipitate dissolved in *N* sodium hydroxide, each to a total volume of 50 c.c. The extinction coefficients of these deep red solutions were measured in a Zeiss colorimeter (green filter, 0·5 cm. cuvette). When the hydrazine is not coupled, the red colour fades immediately. The intensity of the permanent colour is found to be proportional to the amount of hydrazine bound in a similar manner to that occurring in hydrazones[1].

It first occurred to us that, during hydrolysis, free amino-groups had been subjected to oxidation, and that the resulting keto or aldehyde groups had become



100 GM. CASEIN, 1,000 C.C. 0·3 *N* HCl, 10 GM. 2,4-DINITROPHENYLHYDRAZINE HEATED AT 96° WITH RAPID STIRRING. EACH POINT REPRESENTS THE MEAN OF THREE MEASUREMENTS.

coupled with the hydrazine. The ammonia produced in the hydrolysis proved, however, to be even less in the presence of the hydrazine than in its absence. This would appear to exclude the possibility of oxidative de-amination, which would necessarily involve the freeing of ketonic acids into the solution. Furthermore, it was found that most of the hydrazine was coupled to the high-molecular fraction precipitable with trichloracetic acid. Spectrometric investigations of the red colour formed here, and that arising in the dissolution of pyruvic acid 2,4-dinitrophenylhydrazone in alkali, showed that the absorption spectra were almost identical in the two cases. It would thus seem that, at least after a short period of hydrolysis, groups are present in the protein framework which, without being ketone or aldehyde structures, permit the coupling of the hydrazine in the normal manner, that is, with the formation of the group =N—N=CR—. It may be mentioned that the dipeptides of amino-acids (for example, glycyl glycine and leucyl leucine) do not give this reaction. Tyrosine and arginine give very weak reactions of the same type.

A consideration of the possible seats of the reaction has led us to the tentative conclusion that the occurrence of amidine groups in the protein framework would provide an explanation for the observed phenomenon. A mechanism for the formation of the amidine structure in the protein framework may be found in the condensation of two adjacent peptide bonds, one of the normal and one of the enolized type:

$$\begin{array}{c} \text{—C(OH)=N—} \\ \text{—NH—CO—} \end{array} \longrightarrow \begin{array}{c} \text{—C=N—} \\ | \\ \text{—N—CO—} \end{array}$$

An arrangement of such amidine groups regularly distributed through the protein molecule permits a rigid fixation of the polypeptide chains into a framework more clearly defined in the crystalline sense. During hydrolysis in the absence of hydrazine, the amidine groups may each take up one molecule of water, thus causing disintegration into polypeptide chains, which may then be subject to further hydrolysis. The hydrazine molecule may break the —C=N— bonds of the amidine structure and thus become coupled with the high-molecular framework.

Experiments with benzoyl aminoacetamidine and other amidines show that these all react with 2,4-dinitrophenylhydrazine, giving very strong colour reactions of the same type. It is, indeed, well known

that amidines react with phenylhydrazines in such a manner that the imino group is exchanged for the reactive group of the hydrazine.

It is also of interest to note that the reaction of the 2,4-dinitrophenylhydrazine under our mild hydrolytic conditions is by no means continuous. Curves showing the relation between time of hydrolysis and colour intensity of the solution in sodium hydroxide of the fraction precipitated by trichloracetic acid exhibit definite discontinuities which are, in principle, reproducible. A pair of typical curves is shown in the accompanying graph. While no explanation of the phenomenon can be given at present, it is conceivable that it is connected in some manner with a successive destruction and regeneration of groups capable of fixing the hydrazine. This in turn may be related to the discontinuous liberation of tyrosine and arginine which we have observed colorimetrically in the filtrates from the trichloracetic acid precipitations in the absence of 2,4-dinitrophenylhydrazine.

An extended account of this work will be published elsewhere.

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[1] Sealock and Scherp, *J. Biol. Chem.*, 140, cxiv (1941).

Distribution of Nucleic Acid in the Cell

THE statements which Stedman and Stedman[1,2,3] have published in NATURE must, it seems, be considered from two points of view. First, there is their chemical analysis leading to the discovery of "chromosomin". Secondly, there are the biological consequences which they have inferred from this discovery. Clearly, the chemical analysis is the foundation of everything else; but since no particulars of this analysis have been published, we can deal only with the superstructure.

The chief of Stedman and Stedman's inferences concerns the distribution of thymo-nucleic acid in the nucleus. They infer that the bulk of the thymonucleic acid lies in the nuclear sap, not in the chromosomes. Their own tables, however, demonstrate the contrary. They have determined the proportion of thymonucleic acid in the dry weight of nuclei varying between the extremes of no nuclear sap in cod sperm to, say, 90 per cent in carcinoma cells. The small variation in proportion of thymonucleic acid is not correlated with the proportion of nuclear sap. Yet it is on the basis of these results that Stedman and Stedman proceed to dismiss the work of Mazia and Jaeger, Caspersson, Norberg and Barigozzi[4], who by four different methods have converged on the conclusion that thymonucleic acid exists in the cell only in structural relationship with the chromosomes.

This conclusion continues to be reinforced by new evidence. For example, Claude and Potter[5] have recently, by a simple technique, isolated chromosome threads from resting nuclei. By chemical analysis of the threads they conclude that 40 per cent is thymonucleic acid, which agrees closely enough with the proportion determined by Norberg, and the threads were, of course, Feulgen positive. Thus thymonucleic acid was evidently attached to the chromosome threads before their isolation. Stedman and Stedman's theory of indirect staining by Feulgen's reagent becomes meaningless in the light of this experiment. On the other hand, Choudhuri's observation[6] of the staining of chromosomes by "developed Feulgen reagent", which has been used by Stedman and Stedman in support of their theory, is, of course, merely another example of the use of a basic dye.

Stedman and Stedman's view that thymonucleic acid is the main solid constituent of the nuclear sap leads them further: "it is an attractive hypothesis", they say[1], "but one for which there is no direct experimental proof, that the spindle which is formed at metaphase is a gel of nucleic acid". Later[3] they state, without additional evidence, that "there seems little doubt that nucleic acid is concerned mainly with spindle formation".

Darlington[7] has given reasons for believing that the development of the spindle depends on a reaction between the centromeres of the chromosomes and fibre-forming molecules of a type not usually found within the nuclear membrane. The spindle can therefore develop only after the breakdown of the nuclear membrane. With regard to the nature of these fibre-forming molecules, most workers have contented themselves with the evidence that the spindle, like other cytoplasmic constituents, does not contain thymonucleic acid. On this point the work of Schmidt and others on birefringence is directly significant. Schmidt[8], Runström[9] and Nakamura[10] have shown that the spindle fibres are positively birefringent with respect to their length, whereas pure sodium thymonucleate fibres are negatively birefringent, thus giving the peculiar optical properties actually found in the chromosomes.

In the light of this evidence, we feel that the position and function of "chromosomin" in the nucleus will have to be determined in relation to the already well-established position and function of thymonucleic acid.

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Dec. 15.

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[2] Stedman, E., and Stedman, E., NATURE, 152, 503 (1943).
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[8] Schmidt, W. J., "Die Doppelbrechung von Karyoplasma, Zytoplasma und Metaplasma" (Berlin, 1937).
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[10] Nakamura, T., *Cytologia Fujii Jub. Vol.*, 482 (1937).

Influence of an Adsorbed (Inner) Layer on the Cohesion of a Solid

IN a previous communication[1] attention was directed to the influence of adsorption in causing the phenomenon of floating drops. In other words, an adsorbed layer (in particular of gases), when enclosed within a liquid, may lessen its cohesion so that no coalescence takes place, the adsorbed layer acting as a barrier. Thus a drop of molten paraffin—where adsorption may be expected—persists for a relatively long time, say, 1 min., on a paraffin surface.

These observations were extended to solid paraffin, using the following principle. Two plane surfaces

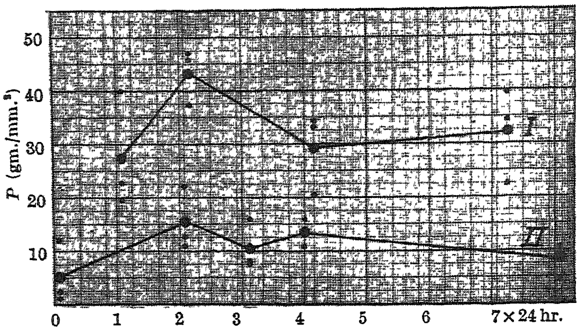

Fig. 1.

of two paraffin cylinders, if brought into contact under a definite pressure, will stick more or less firmly. This provides a measure of the resulting cohesion at the contact surface. Two cases may be considered: (1) If the surfaces have been formed by cutting at room temperature, no sensible adsorption is to be expected. (2) If the cut specimens have been exposed to tempering, a sensible adsorption in the surfaces may be expected. Accordingly, a lessened cohesion ought to occur.

Small cylinders of paraffin (melting at 68–72° C.) were cast in a shape permitting traction tests to be performed. The plane surfaces were smoothed, using a special, sharp turning tool. Two cylinders were pressed together in a small press, using constant load, and time.

The following figures were first obtained.

Treatment after plane turning	Average 'tensile strength'
No tempering	323 gm.
Tempering at 40° C., 17 hr. ..	320 ,,
Tempering at 50° C., 17 hr. ..	17 ,,

While tempering at 40° had practically no effect, tempering at 50° gave a strikingly low tensile strength, intimating that effective adsorption had occurred.

The final tests are exemplified by Fig. 1. The specimens tempered at 50° C. (II) show a considerably lower strength than the untempered ones (I), confirming the above result. Similar data were obtained with paraffin melting at 75–80° C.

Thus, *an adsorbed layer considerably lowers the cohesion appearing in solid paraffin.*

This having been established, similar tests were attempted on lead. The cut surfaces were brought together (1) as soon as possible after cutting, and (2) after a definite period t, permitting the air to form a thin foreign layer on the surfaces. This foreign layer was found strongly to diminish the cohesion. The results, however, were irregular, on account of too rapid formation of the adsorbed (oxide) layer.

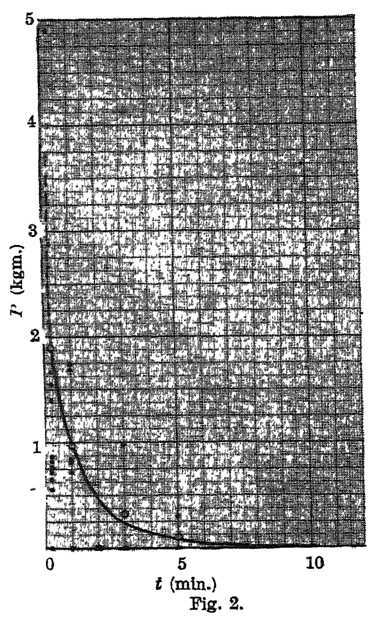

Fig. 2.

Tin was found to be more appropriate. Fig. 2 illustrates the tensile strengths P obtained after different times t of exposure after cutting. It will be seen that the average values (circles) lie fairly well on a smooth curve. This gives evidence that on increasing exposure time t a striking decrease of the sticking power occurs, so that after $t = 10$ min., no sticking whatever was obtained. At first the slope of the curve is very steep. We infer that even an extremely thin adsorbed layer strongly diminishes cohesion with solid tin.

The conclusion is thus that the action exerted by a thin (adsorbed) layer in lowering cohesion, which has been evidenced for different liquids and now for solid paraffin, likewise occurs in the case of a solid metal (lead and tin). This experimental result is important in the phenomenon of grain growth in metals.

Further details will appear in *Arkiv för Matematik, Astronomi och Fysik*, vol. 30 A, of the Royal Swedish Academy of Sciences, Stockholm.

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[1] NATURE [153, 80 (1944)].

Biology of the Malarial Parasite in the Vertebrate Host

DURING the last few years an increasing amount of interest has been centred in the so-called exoerythrocytic stage which has been demonstrated in the life-cycle of certain malarial parasites of birds. The first really clear proof that schizogony of a malarial parasite could occur in cells other than red blood corpuscles was given by Huff and Bloom[1], who demonstrated that *Plasmodium elongatum* successfully parasitized not only erythrocytes, but also monocytes and lymphocytes, and a variety of cells in the bone-marrow and the spleen. Next Raffaele[9] described some tissue forms of *Plasmodium relictum* found by him in canaries which had been infected by means of sporozoites, but it was the work of James and Tate[4] which finally attracted the attention of malariologists all over the world to the possible great importance of what they called an exoerythrocytic stage in the life-cycle of malarial parasites. They found that the schizogonic cycle of *Plasmodium gallinaceum* in chickens took place not only in the erythrocytes, but also in endothelial cells throughout the tissues of the body. The parasites in the endothelial cells developed to a much larger size than in the erythrocytes, and also, because of the absence of hæmoglobin from the host cells, they were unpigmented. They were plentiful in the endothelial cells of the brain and spleen, but easily found, too, in the liver, lungs and kidneys. They were present in much greater numbers in an infection induced by sporozoites than in an infection induced by simple inoculation of infected corpuscles[3]. A feature of these exoerythrocytic parasites was their great refractoriness to drugs such as quinine and atebrin,

and it was suggested that such forms might be present in human malaria and constitute the explanation of why relapses so frequently occur. Clearly, this suggestion made the problem of exoerythrocytic forms of the greatest possible importance.

The work of James and Tate has been confirmed many times, and in addition exoerythrocytic forms have since been described in other malarial parasites of birds; for example, in *Plasmodium circumflexum*[7] and in *Plasmodium cathemerium*[5,6]. Sometimes these forms have been found only if the infection in the bird has been induced by sporozoites, although it has been claimed[7] that they are present in *Plasmodium circumflexum* infections if these have been induced by inoculation of parasitized cells (for a full review of the position, see Porter and Huff[8]). Experiments in these laboratories indicate, however, that the exoerythrocytic forms described by different workers in different species, and in different stages of the disease in the same species, are not all analogous stages in the life-history of the malarial parasite, and that, in fact, the only feature they may have in common is that they do not occur in red blood cells. Because of the War these experiments cannot be described in detail, but it is felt that the conclusions which they have suggested should be published because they help to clarify the problem of exoerythrocytic schizogony. The conclusions are:

(*a*) When sporozoites are introduced into the blood stream they do not persist there for more than a short time (a matter of minutes in the case of sporozoites of *Plasmodium gallinaceum*), but quickly penetrate the tissues.

(*b*) Within the tissues they pass through a developmental phase. The duration of this 'primary tissue phase' constitutes the incubation period of the infection or, more strictly, the prepatent period. Recently, the name cryptozoites has been given to the parasites of the primary tissue phase[2].

(*c*) Following the end of the developmental primary tissue phase there is a release of parasites into the blood stream and, in the case of *Plasmodium gallinaceum*, into further tissue cells, giving rise to a secondary tissue phase (the original exoerythrocytic stage of James and Tate).

(*d*) The primary tissue phase is essentially developmental and only follows the introduction of sporozoites; the secondary tissue phase of *Plasmodium gallinaceum* may be formed from the primary tissue phase or it may be initiated by blood parasites. Unlike the primary tissue phase the secondary tissue phase is capable of indefinite schizogony, and may persist as long as an infection lasts.

(*e*) The primary tissue phase and the secondary tissue phase react differently to certain drugs.

In diagrammatic form these conclusions can be illustrated as follows:

$$\begin{tikzcd}
 & & \text{blood phase} \arrow[dr, shift left] & \\
\text{sporozoites} \arrow[r] & \text{primary tissue phase} \arrow[ur] \arrow[rr] & & \text{secondary tissue phase.} \arrow[ul, shift left]
\end{tikzcd}$$

It seems to us that the primary tissue phase is probably common to all malarial parasites, but so far the secondary tissue phase has been described definitely only in the case of *Plasmodium gallinaceum* and, if the term exoerythrocytic is used literally, in the case of *Plasmodium elongatum*, but probably, also, in the case of *Plasmodium circumflexum* and *Plasmodium cathemerium*. The secondary tissue phases of *Plasmodium elongatum* and *Plasmodium gallinaceum* are quite different from one another, and it might well be that this phase is a specialized feature of only a few malarial parasites, taking a different form in the different species—its great development in *Plasmodium gallinaceum* is certainly specialized. It remains an urgent problem to determine whether a secondary tissue phase exists in any of the species causing human malaria, because in it lies an answer to the problem of relapses.

The conclusions have their bearing on the problems of malarial chemotherapy. It will be clear that there might be as many as five forms of a malarial parasite which react specifically to drugs, namely, the sporozoite, the primary tissue phase, the secondary tissue phase, the schizonts of the red blood cells and the gametocytes. A true causal prophylactic drug will act either on the sporozoites or on the primary tissue phase, but a drug which suppresses the blood phase as it arises from the primary tissue phase will simulate causal prophylactic action which, we think, is what Mepacrine (atebrin) sometimes does when it is taken prophylactically; at least we have no evidence that it kills sporozoites, and we know that it does not kill the primary tissue phase in bird malaria.

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[1] Huff, C. G., and Bloom, W., *J. Infect. Dis.*, **57**, 314 (1935).
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[9] Raffaele, G., *Riv. Malariol.*, **15**, 318 (1936).

Manganese Hunger in Animals

WHILE engaged in an investigation, under the auspices of the Indian Research Fund Association, on the role of manganese in the synthesis of ascorbic acid by animals, an interesting observation has been made.

Rabbits were kept on a synthetic diet of purified ingredients and suitably supplemented to make it complete in the known factors except ascorbic acid. The salt mixture given was a modified salt mixture No. 185 of McCollum and Davies. When the animals were housed together in cages provided with galvanized screen bottoms, they were found, after a time, to pluck one another's fur and eat it. They also went greedily after whatever came their way by chance such as wood, cork, etc. The controls, supplemented with manganese, did not exhibit any such unusual behaviour. Rats kept on similar manganese-free diet also showed, in contrast to controls supplemented with manganese, a hankering for wood, cork, thread, etc., whenever they could get at them. They also licked the metal of the cages. When kept on this diet for a long period, they ceased to grow normally and eventually the experimental animals started dying out. Post-mortem examination revealed hæmorrhages of the lungs, liver and the intestinal capillaries. Once, when one animal out of a group of four died, the survivors ate the viscera of the dead one.

The plucking and eating of one another's fur by the rabbits, the eating of the dead animal's viscera by the surviving rats and the hankering of the manganese-deprived animals for any titbits seem to have been due to the lack of manganese in the diet.

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Chalk Brood Attacking a Wild Bee

A PIECE of partly decayed deal tunnelled by an insect received for identification in September from Acton, London, was found to contain the nest of a leaf-cutting bee, probably a Megachile sp. The wood had been split for firewood and only one cell of a series in the tunnel remained intact. The cells were formed by lining the tunnel with pieces cut from hawthorn leaves and contained a dead pupa and a food store consisting of a pellet of pollen massed together with honey. The pollen proved to be that of a composite with spiny grains 35–42 μ in diameter comparable in size and ornamentation with those of the creeping thistle, *Cirsium arvense* Scop. The purity of the pollen store suggests that this wild bee confines its attention to one species of plant at a time, a habit regarded as characteristic of the honey bee. The pupa and pollen store were invested with a white mycelium in which small black fruiting bodies were observed. On examination the fungus proved to be *Pericystis apis* Maassen, the pathogen responsible for the chalk brood disease of the honey bee. We are not aware of earlier records of this fungus attacking wild bees, though this may not be due to a scarcity of the fungus but to the infrequency with which such material comes under the notice of a mycologist.

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The So-called Plücker's Plane

ONE is accustomed to see 'Plücker's plane' explained as an effect of a magnetic field on particles which, supposedly paramagnetic, arrange themselves somewhat as iron filings would.

I have observed, however, that the effect is wholly explained by the ordinary magnetic deflexion of the slow-speed cathode rays, which, issuing normally from the cathode and projecting secondary ions beyond their own range, cause, with a cylindrical cathode, the familiar cylindrical negative glow. In fields of 200–300 gausses or more, a substantially regular 'plane' appears, because all particles not originally travelling along the lines of force (that is, in 'Plücker's plane') are dissipated by the strong magnetic deflexion; but in weaker fields, of 100 gausses or less, the process of magnetic deflexion from the other parts of the cylindrical glow is very evident—in opposite directions on the two sides of the 'plane'—and this explanation is further shown to be correct by asymmetrical displacement if the poles are inclined. The more intense spots of light near the poles, if these are conical, are due to spiralling concentration along the lines of force. Again, the 'plane' is unaffected by a change from knife-edge to extensive plane poles, although in the latter case the field is uniform throughout the tube. If two poles near one another are brought to one side of the tube, so as to give the greatest possible field gradient, there results a dark space opposite the gap, due to deflexion away from there, whereas 'magnetic' particles would fill this space more densely than in the absence of the field.

If the 'ions' have any paramagnetism, it is not apparent under these various conditions. The 'hoariness' of the fallacious view of this nearly century-old experiment is remarkable, seeing that it requires the supposition of some novel kind of intensely magnetic ion formed near the cathode.

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Metallic Searchlight Mirrors

IN my Parsons Memorial Lecture delivered before the Physical Society on October 15, 1943, and published in NATURE of December 10, I said that "Metal searchlight mirrors, though occasionally revived, are now almost obsolete, at any rate in Great Britain, owing to the inferiority of reflecting power and the difficulty of maintaining it good under service conditions"; this statement was in accordance with what I had been able to find in print, and with what I had been able to learn personally concerning military searchlights. A certain type of metallic mirror had, in fact, been recently discarded from the service.

I now learn from Messrs Clarke, Chapman and Co., Ltd., of Gateshead-on-Tyne, that after spending a large sum on development, they have been able to overcome the difficulties, and are making metallic mirrors which are able to stand service conditions.

I knew nothing of this at the time of writing and regret not having made fuller inquiries before undertaking to say anything about the subject.

It is hoped that this letter may correct any harm that has been done.

RAYLEIGH.

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Jan. 6.

J. B. Hannay and the Artificial Production of Diamonds

WITH regard to Dr. Travers' letter in NATURE of December 18, p. 726, Mr. Hannay and my father were partners in some of his industrial developments. Some time after the diamond experiments were made, I remember attempts to piece together certain fragments under the microscope. I understood that Mr. Hannay was concerned lest some practical joker had interfered with the experiments as had been suggested. He, himself, was not the type of man to fake a result. He was certainly interested to check that no one else had.

JAMES WEIR FRENCH.

Barr and Stroud, Limited,
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RESEARCH ITEMS

Tent Caterpillar in India

K. A. Rahman and A. N. Kalra have described the life-history of the tent caterpillar (*Malacosoma indica* Wlk.) in the Simla Hills (*Proc. Indian Acad. Sci.*, 18, Sect. B, No. 2; 1943). The egg masses, resembling those of the notorious tent caterpillar of America, were found deposited on branches and twigs of a number of apple, and a few pear, trees, during the course of an entomological survey of the orchards in the Kotgarh ilaqa (Simla Hills) in July–August 1940. The eggs hatched out in the laboratory at Kotgarh were kept under observation, and in due course the adults were identified as *Malacosoma indica*. The pest has been recorded from apple, pear, apricot, walnut, *shaigal* (Pyrus sp.) and *ban* (*Quercus incona*), the apple suffering most severely and occasionally the pear. The pest hibernates in the egg stage, the females laying eggs as broad bands around branches of the plant, each band covered by a protective layer of dark brown gluey substance. When buds appear (about the middle of March) the eggs hatch out. The egg-stage lasts for about nine or ten months. The larvæ live gregariously, and soon after hatching spin a silken nest or tent in a sheltered place on the plant. As the larvæ grow the tent increases, finally reaching a length of 1–1½ ft. There may be eighteen to twenty-five tents on each plant. The larvæ live in the tent by day and eat the leaves of the plant at night. When fully fed, the larvæ spin silken cocoons in protected places and pupate. The duration of life is from thirty-nine to sixty-eight days. There is only one generation in a year, the moths emerging in May and June, the duration of the total life-cycle being about a year. The entire plant may be stripped bare of leaves, only the ribs and harder veins remaining, and such plants bear no fruit. In the absence of leaves the young caterpillars may eat the tender bark.

Researches on Indian Myxosporidia

M. CHAKRAVARTY has described twelve species of Myxosporidia parasitizing fishes ("Studies on Myxosporidia from the Common Food Fishes of Bengal", *Proc. Indian Acad. Sci.*, 18, Sect. B, No. 2; 1943). Eight of these are new species and the remainder are little known in India. Most of the fishes studied were collected from local tanks or purchased from Calcutta markets. Some were kept in large aquaria in the laboratory. Most of these parasites were in the gall bladder, but one of them, *Myxobolus clarii* n.sp., was also found in the liver, testes, ovary and fat bodies, and two, *Myxobolus catlæ* n.sp. and *Thelohanellus rohitæ* (Southwell and Prasad), in the gills. Infection experiments of the fingerlings of those fishes acting as hosts for *Myxobolus catlæ* proved fatal under laboratory conditions. The parasites, particularly the spores, were mainly observed in the fresh condition, different reagents being used for special purposes.

Free Border of Intestinal Cells

A LITTLE more than a hundred years ago Henle described a free border, *freie oberfläche*, in the intestinal cells of vertebrates. Since then, owing to its obvious importance from the point of view of absorption, it has been studied by a number of authors and received a variety of names according to the interpretation of its striated appearance as seen in section. Two major conflicting interpretations have been set forth; in one it is considered to be composed of cilia or rods, and in the other the striation is supposed to result from the presence of pores or canals. The latest investigation of this interesting topic by means of most careful and modern technique is that by John R. Baker (*Quart. J. Micro. Sci.*, 84; 1942). He is a supporter of the pore theory and considers that the free border in Tetrapoda consists of a layer next to the lumen of the intestine perforated by a number of pores, a thicker layer traversed by canals at right angles to the surface and communicating with the pores, and lastly a granular layer which lies next to the cytoplasm of the cell. The suggestion is put forward that unhydrolysed fats pass through the canals in extremely fine droplets.

Nemertean Worm of the Genus Gorgonorhynchus

IN 1930 W. J. Dakin discovered a new type of Nemertean worm in Australia which he placed in a new genus, Gorgonorhynchus, and reported it in NATURE (128, 796; 1931). While typically heteronemertean in all other respects, it differs from all other members of the group in having a much branched proboscis instead of an unbranched one. In 1931 Dakin received material from India which showed it to be present there also. The following year Dr. F. J. G. Wheeler, without any knowledge of these discoveries, collected it in the Bermudas, and he has now published a discussion on its possible bearing on evolutionary theory (*Amer. Nat.*, 1943). The author points out that it was found in these three widely separated regions at about the same time but was previously unnoticed in any of them. Moreover it is common, found intertidally at all times of the year and is large enough not to escape detection by shore collectors. Marine zoologists had collected in the same areas previously, and in the Bermudas particularly two experts on the Nemerteans, Verrill and Coe, had collected intensively on the same beaches where it is now common. Dispersal may account for its appearance in India and Australia but can scarcely be held to explain its turning up in Bermuda within such a short time. The author suggests, as a possibility, an almost simultaneous gene mutation in closely related members of a group of Heteronemerteans.

Studies of Hydracarina

IN two recent publications, O. Lundblad has made noteworthy contributions to our knowledge of the Hydracarina. One (*Arkiv. Zool.*, 24; 1942) treats of those from Madeira, and the other (*Kungl. Svenska Vetensk.*, 20; 1943) those belonging to the genus Koenikea *sens. lat.* from Brazil. Both are fully illustrated by text figures and by plates containing numerous reproductions of photographs, many of them of types or allotypes. From Madeira 25 species are described and of these 24 are new or, if previously reported in brief by the author, are here more fully described with their nymphs. In spite of this large number of endemic forms only one genus, Maderomegapus, is so far peculiar to the island, and indeed all the other genera have been recorded from Great Britain. The genus Koenikea is one of the richest in species of all the South American genera and is represented by 49 species and 13 varieties, whereas in North America only 6 species of it are known. 71 species and varieties are dealt with in the text, and appended to it are a

key to the 11 subgenera of Koenikea found in South America and another key to the American species of the genus.

Studies of Bryozoa

IN two recent publications from Brazil (*Bol. Faculd. Filos. Cien. e Letr. Zoologia*, No. 5, 1941 and No. 6, 1942) E. Marcus has described a number of points in the structure and development of a whole range of Bryozoa including Entoprocta, Ectoprocta and Phylactolæmata. The papers are illustrated with 22 plates and both plates and text are unusually well produced; fortunately also for many readers each paper is provided with an adequate summary in English. While the work is mainly concerned with structural and developmental features, it does nevertheless bring out a number of points that are useful from the systematic aspect. In the earlier paper the author describes in detail the life-history of *Nosema bryozoides*, a microsporidian parasite of the Bryozoa, here occurring as *Stolea evelinæ*.

Noise Measurements in Vacuum Tubes

IN long-distance transmission systems, there must always be an adequate margin between signal and noise. Noise introduced at the point where the signal level is at its lowest—that is, at the input to each amplifier—will limit the permissible line attenuation and hence the length of line between repeater stations. Close control of tube noise is therefore of importance in keeping down the cost of the system without sacrificing telephone quality. Noise output of an amplifier the input circuit of which is a pure resistance is the sum of the effects of thermal noise in the input resistance and of tube noise. If the amplifier had a perfectly quiet tube in its first stage, the noise measured by a meter in the output circuit would be due to the thermal noise. Replacing the quiet tube by an average tube would increase the power output of the amplifier by an amount due to tube noise. Several measuring sets for determining tube noise have been devised on this principle. A new one, described in an article by J. J. DeBuske (*Bell Lab. Rec.*, 21, No. 12; August 1943), was set up to meet the need for a fast and simple method of measuring, under actual operating conditions, the noise contributed by a tube in the first stage of the line amplifier in *K*1 carrier systems. The 135-ohm input termination is connected to the input circuit of amplifier No. 1, which is the *K*1 carrier line type. This input circuit consists essentially of a transformer with impedance ratio of 135 : 30,000 and a 30,000 ohm termination on the high side which is connected to the grid of the tube under test. An attenuator, a filter, a second amplifier and a calibrated thermocouple meter, which serves as a power-measuring device, complete the equipment.

Dimethyl Ether Compound with Boron Trifluoride

CONSIDERABLE interest is attached to the compound formed from dimethyl ether and boron trifluoride in which presumably a co-ordinaté (or donor-acceptor) link between the boron and oxygen is present $(CH_3)_2O \rightarrow BCl_3$. The structure of the molecule has now been investigated by the electron diffraction method (S. H. Bauer, G. R. Finlay and A. W. Laubengayer, *J. Amer. Chem. Soc.*, 65, 889; 1943). The boron valency angles are tetrahedral, the distances are B—F $1 \cdot 41 \pm 0 \cdot 02$ A., B—O $1 \cdot 52 \pm 0 \cdot 06$ A. The ether part remains essentially unaffected: at most, the C—O separation is increased from 1·42 to 1·44 A. It is probable, but not certain, that the oxygen valency angles are tetrahedral. The conclusion reached from energy considerations is that the bond formed between boron and oxygen is due to an electron pair rather than to dipole-dipole interaction.

Partition of Energy among the Stars of the Galaxy

THE results of an important statistical study of stars of different spectral types are summarized by Vyssotsky and Williams in the current *Astrophysical Journal* (98, 185; 1943), and are discussed by them in a paper which follows (p. 187). The basis of the work is a spectral classification of 7,600 stars in 441 sample regions distributed fairly uniformly over two thirds of the sky. The plates were taken on the 10-in. prismatic camera of the Leander McCormick Observatory, and the counts are complete down to photovisual magnitude 11·5. The data are discussed from the point of view of galactic concentration, and it is plainly shown that for stars at the same distance the dwarfs cluster much more closely to the galactic plane than do the giants. A surprisingly close representation of the curves connecting observed star density with galactic latitude can be obtained by assuming equipartition of energy among the stars of the main sequence. The much smaller apparent concentrations of stars of the giant branch are consistent with larger kinetic energies; *K*-type giants, for example, have velocities perpendicular to the galactic plane which are twice as big as those of the *A*-type stars. This evidence strengthens that already obtained from a recent McCormick investigation in which the mean kinetic energy of dwarf *M* stars, selected without regard to their proper motions, was found to be equal to that of the *A* stars. Evidently the Galaxy in our vicinity must be regarded as an imperfect mixture of two kinetic systems, in one at least of which (the main-sequence stars, or dwarfs) equipartition of energy prevails.

Origin of the Zodiacal Light

A NEW theory of the zodiacal light is given in a paper by V. G. Fessenkoff (*Astro. J. Soviet Union*, 19, No. 4; 1942) summarized in the current issue of the *Astrophysical Journal* (98, 129; 1943). That the light is sunlight scattered by small dust particles is now common ground; the problem consists in accounting for the existence in the solar neighbourhood of an oblate cloud of cosmic dust of density decreasing somewhat more rapidly than the inverse distance from the sun. The new hypothesis is that this matter arises from collisions between sporadic meteors and the asteroids. It is known that planets and satellites devoid of an atmosphere are subjected to a meteoritic bombardment which is probably responsible for their observed surface layers of pulverized rocks. The small asteroids suffer the same bombardment, but their gravitational attraction is not enough to retain the resulting dust particles; and since their total surface is enormously greater than that of a major planet, the process of dust production must be especially efficient in the asteroid zone. Fessenkoff finds that a dust cloud produced in this way will form an oblate spheroid, with the sun at its centre, surrounded by a dense ring of particles in the asteroid zone. The former is responsible for the conical zodiacal light: the latter for the uniform zodiacal band visible along the entire ecliptic throughout the night.

NITROGEN LOSS FROM SOILS AND OXIDE SURFACES

By PROF. N. R. DHAR and DR. N. N. PANT
Indian Institute of Soil Science, Allahabad

IT has been reported[1] that when a virgin soil is brought under cultivation, the percentage of total nitrogen usually falls off with time up to a limiting value. A loss of nitrogen from soils on the addition of nitrogenous compounds, especially when the conditions are favourable for oxidation, has also been observed by different investigators; but this phenomenon has been explained satisfactorily by Dhar and collaborators[2], who have postulated that this type of nitrogen loss in soils is chiefly due to the formation and decomposition of the unstable ammonium nitrite produced in the processes of ammonification and nitrification. There is also the possibility of the reaction of nitrous acid on amines, amides and amino-acids which may sometimes be present in the soil or formed in the decomposition of soil organic substances. It has also been reported that soil loses nitrogen in the form of nitrogen gas much less when manured with sodium or potassium nitrate than when treated with ammonium sulphate, urea or other organic nitrogenous manures.

It has been shown in a number of papers that this phenomenon of denitrification is accelerated by light and by the presence of acids, and markedly retarded by carbonaceous substances like sugar, molasses, cellulose, etc. The loss of nitrogen is enhanced by increase of temperature, and at the same temperature this loss is much greater in sunlight than in the dark. From our experiments on the processes of ammonification and nitrification of different nitrogenous compounds in presence of sterile and unsterile soils and with photo-active surfaces like titanium oxide, zinc oxide and iron oxide (Fe_2O_3), it has been concluded that the amounts ammonified and nitrified and the loss of total nitrogen are much greater in light than in the dark in both sterile and unsterile conditions, and the phenomena of ammonification and nitrification can take place in the complete absence of micro-organisms.

In order to establish that the phenomenon of denitrification can be a non-bacterial process, careful experiments under completely sterile condition have recently been carried out. 2 gm. urea and 2 gm. gelatine are first autoclaved in the dry condition in a number of boiling tubes for 10 minutes at 15 lb. pressure. These substances were added under aseptic condition separately to 600 c.c. Pyrex glass flasks, some containing 100 gm. sterilized soil with 100 c.c. autoclaved distilled water, and others containing only sterilized oxides (1 gm. titanium oxide and 0·1 gm. zinc oxide) with 50 c.c. autoclaved distilled water. To one set of these flasks, previously sterilized, glucose was added, and finally all the flasks are sterilized by steaming for more than twenty minutes. One set of flasks was covered with black cloth to cut off light and the other set exposed to sunlight for 8 hours every day. In order to eliminate the temperature effect, the dark set was also placed in sunlight. The exposure continued for 650 hours. At the end of the exposure, all the sets were tested and found free from any bacterial contamination. The contents of the flasks were analysed for total carbon and nitrogen at the end of the exposure, after adding a few drops of dilute sulphuric acid to prevent loss of ammonia during analysis. The following results were obtained:

TABLE 1. EXPERIMENTAL FLASKS UNCOVERED IN SUNLIGHT.
Total nitrogen introduced in soil sets = 289·3 mgm. in oxide sets = 249 6 mgm. nitrogen.

	Total carbon introduced (gm.)	Total carbon unoxidized (gm.)	Total carbon oxidized (gm.)	Total nitrogen (mgm.)	Total loss (mgm.)
	per cent	per cent	per cent	per cent	per cent
(1) Soil + gelatine + 0 gm glucose	1·0294	0 9467	0 0827	251·10	38·20
(2) Soil + gelatine + 1 gm. glucose	1 4294	1·2389	0·1905	278·50	10·80
(3) Soil + gelatine + 3 gm. glucose	2·2294	1·9371	0·2923	284·70	4·60
(4) Soil + gelatine + 5 gm. glucose	3·0294	2·6807	0·3487	284·70	4·60
(5) Oxides + gelatine + 0 gm. glucose	0 6172	0 5598	0·0574	229 80	19·80
(6) Oxides + gelatine − 1 gm. glucose	1·0172	0·9060	0·1112	240·90	8·7

TABLE 2 EXPERIMENTAL FLASKS COVERED.

	Total carbon introduced (gm.)	Total carbon unoxidized (gm.)	Total carbon oxidized (gm.)	Total nitrogen (mgm.)	Total nitrogen loss (mgm.)
	per cent	per cent	per cent	per cent	per cent
(1) Soil + gelatine + 0 gm. glucose	1 0294	0·9866	0 0428	273·60	13·70
(2) Soil + gelatine + 1 gm. glucose	1·4294	1·2982	0 1312	284·50	4·80
(3) Soil + gelatine + 3 gm. glucose	2·2294	2·0189	0·2105	286·70	2·60
(4) Soil + gelatine + 5 gm. glucose	3·0294	2·7712	0·2582	286·80	2·50
(5) Oxides + gelatine + 0 gm. glucose	0 6172	0·5780	0·0392	243·80	5·80
(6) Oxides + gelatine + 1 gm. glucose	1 0172	0·9575	0·0597	246·20	3·40

TABLE 3 EXPERIMENTAL FLASKS UNCOVERED IN SUNLIGHT.
Total nitrogen introduced in soil sets = 974·6 mgm.; in oxide sets = 933 4 mgm.

	Total carbon introduced (gm.)	Total carbon unoxidized (gm.)	Total carbon oxidized (gm.)	Total nitrogen (mgm.)	Total nitrogen loss (mgm.)
	per cent	per cent	per cent	per cent	per cent
(1) Soil + urea + 0 gm. glucose	0·8842	0·7410	0·1432	907·40	67·20
(2) Soil + urea + 1 gm. glucose	1·2842	1·0634	0·2208	951·10	23·50
(3) Soil + urea + 3 gm. glucose	2·0842	1·7576	0·3266	967·40	7·20
(4) Soil + urea + 5 gm. glucose	2·8842	2·5217	0·3625	969·20	5·40
(5) Oxides + urea + 0 gm. glucose	0·40	0·3062	0·0938	900 70	32·70
(6) Oxides + urea + 1 gm. glucose	0·80	0·6435	0·1565	920·20	13·20

TABLE 4. EXPERIMENTAL FLASK COVERED.

	Total nitrogen introduced (gm.)	Total nitrogen unoxidized (gm.)	Total nitrogen oxidized (gm.)	Total nitrogen (mgm.)	Total nitrogen loss (mgm.)
	per cent	per cent	per cent	per cent	per cent
(1) Soil + urea + 0 gm. glucose	0·8842	0·7977	0·0865	953·20	21·40
(2) Soil + urea + 1 gm. glucose	1·2842	1·1094	0·1748	966·30	8·30
(3) Soil + urea + 3 gm. glucose	2·0542	1·8417	0·2425	969·00	5·60
(4) Soil + urea + 5 gm. glucose	2·8842	2·6030	0·2812	971·40	3·20
(5) Oxides + urea + 0 gm. glucose	0·40	0·3498	0·0502	922·60	10·8
(4) Oxides + urea +1 gm. glucose	0·80	0·6982	0·1018	927·70	5·7

From the foregoing results it is clear that nitrogen is lost both in soil and with oxide surfaces on the decomposition of urea and gelatine, even in the complete absence of micro-organisms. The loss of nitrogen is greater in light than in the dark. No doubt the denitrification is much less with the oxide surfaces than with the soil, but the surface offered by the oxide is much less than that presented by the soil. Moreover, the addition of glucose markedly reduces the amount of denitrification of urea and gelatine in the light as well as in the dark. These results confirm that non-biological denitrification is possible and that light accelerates the process in a marked manner.

[1] Compare Lipman and Blair, *Soil Sci.*, **12**, 1 (1921); Russell and Richards, *J. Agric. Sci.*, **8**, 495 (1917); Russell, "Soil Conditions and Plant Growth", pp. 377–378 (1937).

[2] NATURE, **134**, 572 (1934); *J. Indian Chem. Soc.*, **12**, 67, 77, 756 (1935); **13**, 555 (1936); **15**, 543, 583 (1938); *Proc. Nat. Inst. Sci., India*, **7**, 115 (1941).

AGRICULTURAL EDUCATION ASSOCIATION CONFERENCE

THE half-yearly meeting of the Agricultural Education Association, which was held during January 4–5 at the London School of Hygiene and Tropical Medicine, concerned itself partly with problems of a direct educational interest, and partly with matters of a more technical nature.

A considerable amount of time was devoted to a consideration of the agricultural education of the youth of fifteen and older, a very topical subject in view of the impending changes in the educational scheme of the nation. Mr. A. S. McWilliam, acting headmaster of Lady Manners School, Bakewell, started the discussion with an account of the agricultural 'bias' which has been imparted to the teaching of boys and girls over fourteen years of age in his school. After a good general education in the earlier years, the child is given the choice of grouped subjects, but biology is a compulsory subject for both boys and girls. The biology is divided into three sections, plant biology, animal biology and soil science. The teaching is made as experimental as possible, and agricultural plants, etc., are used as examples. Bees, a demonstration orchard and school clubs form an important part of the system.

Mr. McWilliam said that the bias was introduced in 1920 with the object of making the science course more attractive, improving the examination results, and encouraging the parents to leave their children longer at the school. The object is not to teach boys and girls farming, but to make use of the country way of life in teaching the principles of science. At the same time it was hoped to create in the minds of the children a better understanding of the importance of the fertility of the soil, the biology of the mammal and the principles of nutrition. Both the laboratory and outside work are arranged on the heuristic system whereby the child is allowed to discover some elementary facts by itself.

Dealing with the objection raised in some quarters that the teaching of agricultural science in the secondary schools will not give an adequate grounding in science for the student, who enters an agricultural college or university, Mr. McWilliam said that at Lady Manners School this has not been found to be the case. Boys and girls have gone forward to the universities and colleges and have been as successful as those from other schools. He is convinced that the agricultural bias in the secondary school after the age of fourteen creates a wider outlook, a greater interest in school work and a better understanding of the countryside. But if the schools are to encourage boys and girls to take up agricultural careers, they must be assured of a decent livelihood in circumstances where the amenities are equal to those of the town; to attain this we must have a prosperous countryside able to pay good wages and offer good prospects to the best boys and girls.

Mr. J. Hunter Smith, principal of the Hertfordshire Farm Institute, in speaking of the farm institute as an introduction to adult education, not only gave a detailed educational programme but also strongly stressed the need for non-vocational or cultural subjects in the curriculum. He advocated the establishment of Young People's Colleges in rural districts, equipped with appropriate workshops, where the part-time student could get further education through hand and eye rather than by lecture and book. At the farm institutes he hopes that there will be a new approach to technical instruction by linking it more intimately with living or moving examples and activities, for there is something dead and uninspiring in transcribing notes on breeds of livestock, varieties of cereals and all the dry data that are so frequently provided. He wants the principle of farm management to be absorbed rather than taught, through continual field observation and the study of records.

In Mr. Hunter Smith's opinion, it is extremely important that non-vocational subjects should find a definite and prominent place in the syllabus of every farm institute. It is a mistake to relegate this basic branch of adult education to occasional debates, discussions or special lectures in the evening. The first lecture hour in the morning would be the ideal. That hour would represent just a little of the idea which has borne such bountiful fruit in the Danish high school.

With regard to the demand for training in agriculture that will arise when the Services are demobilized, Mr. Hunter Smith suggested that the first step should be a period of some months up to a full year as a 'working guest' on a suitable farm. Thus by work on the land, and especially by fireside talks in the farm-house, these men would learn what it all means in respect of both work and prospects.

The first of the technical papers to be read was contributed by Dr. John Hammond, on "The Breeding of Cattle for Milk or Meat". He pointed out that the supremacy of British farmers in methods of breeding for beef is based on visual judgment and touch of the animal. These methods are of little use in the breeding of cattle for milk and butter-fat yields, unless they are coupled with complete production records extending over a number of generations. This is probably the reason why we have not attained that supremacy in breeding for milk that we have in beef production. A great extension of milk recording is still required. Unfortunately, milking qualities cannot be measured directly in the bull, and since each year he may contribute thirty-five calves or more to the next generation while the cow produces rather less than one, the importance of paying attention to the bull when breeding for milk is obvious. Dr. Hammond advocated a system of breeding from "proven" bulls similar to that which has given such striking results in Holland, the United States and Denmark in recent years in breeding for milk and butter-fat.

Dr. Hammond is of opinion that we can obtain

only a small proportion of our beef from pure beef herds; the bulk of our beef must be obtained from dual-purpose cattle or from these crossed with a beef bull. To obviate the danger that heifers from this cross may find their way into dairy herds and so reduce the efficiency of the dairy industry, he advised the use of beef bulls having a distinctive colour marking, such as the Hereford (white face) or Aberdeen Angus (black colour), which are dominant genetic characters and so colour-mark their offspring with a trade mark for beef.

A plan for the organization of machinery instruction within the county education framework was outlined by Mr. D. I. McLaren, who contended that the facilities available for obtaining advice on agricultural engineering problems have not kept pace with those provided for the other branches of the industry. Among other recommendations he suggested the inauguration of an advisory service, partly within the county under the charge of a suitably trained man with the status of assistant county agricultural organizer, and partly on a provincial basis, with an adviser in agricultural engineering on the lines of the existing advisers in chemistry, economics, etc.

Mr. C. Davies put in a plea for the reduction of types and varieties of farm machines on the grounds that many of them are not really necessary. He said that the War has taught us to do without many things in ordinary life which were previously considered necessities, and many tools which formerly were considered useless unless of a very exact shape are unobtainable to-day; but we shall find that other shapes do just as well and sometimes even better. In the case of the plough, of which very many types exist, he said that the demands for a particular shape or type are often due, not to a profound knowledge of what the soil requires, but to local custom or prejudice. The same holds good for other farm implements and machinery. Mr. Davies said that it is not in the farmer's own interest to ask for an unnecessary variety of implements, because the fewer the number of different shapes and types a manufacturer has to turn out the lower the costs, and the lower the charge to the farmer. The farmer of the future will have to be more machine-minded, remarked Mr. Davies; no factory can afford to abuse the mechanical equipment it has installed to the same extent as happens on so many farms, and continue to pay dividends. In the discussion on this paper, it was pointed out that the farmer is not entirely to blame in failing to protect his machinery from the weather; the great shortage of suitable farm buildings puts him in a very difficult position, especially now that new construction is limited because of shortage of materials.

IMPROVEMENT OF LIVESTOCK

PROF. ROBERT RAE, of the University of Reading, contributed a valuable address on the improvement of livestock to the proceedings of the National Veterinary Medical Association of Great Britain and Ireland (*Vet. Rec.*, **55**, 429; 1943).

During the War, he said, millions of acres of land have been ploughed up and there have been tremendous increases in crops which can be consumed directly, such as potatoes, barley, wheat, sugar beet and so on. Before the War Great Britain imported ten million tons or so of feeding stuffs for farm animals at a cost of about fifty million pounds a year. Producers of pigs, poultry and milk were most dependent on this, sheep farmers were least so. As the War decreased the shipping available for these imports, first priority in imported foodstuffs was given to dairy cows and milk production, while pigs and poultry came last, because they are almost entirely dependent on the concentrated foods which are largely imported. At the present moment the numbers of our dairy cows have been maintained, with a small increase, but beef cattle and sheep have been reduced to some extent. At the same time our large livestock population has built up reserves of soil fertility which has helped our crop production.

Prof. Rae thinks that livestock production must remain after the War the predominant feature of British agriculture. We shall need fresh (perishable) agricultural products; large areas of Great Britain are not suitable for intensive arable cultivation, although much of this land can be improved; even in our arable areas there is much land which cannot without the fertilizing power of livestock upon it be kept in what the farmer so graphically and beautifully calls 'good heart'. Prof. Rae does not advocate the return of large areas to permanent grass. He thinks that the war-time policy of temporary pastures, endorsed by generations of Scottish farming, should be continued after the War. They give fresh, clean pastures and should give increased stock-carrying capacity and the opportunity of using the fertility accumulated by the livestock. This system of temporary leys has been introduced by the County War Agricultural Committees much more quickly than it could have been introduced in normal times.

Prof. Rae thinks, however, that we do not produce enough food for even our pre-war numbers of livestock. We ought to revert to our pre-War numbers of livestock or to increase them, and, if we do, we shall need imported foods again after the War. Further, Great Britain has often been called the stud farm of the world. The best herds and flocks of many other countries, of the Dominions Overseas and of North and South America were founded on stock supplied by Great Britain, and our pre-War trade in breeding stock was valuable. We could, indeed, be proud of our breeding stock; but we could not be satisfied with a good deal of our ordinary stock in the fields. The level of all livestock in Great Britain needs to be raised; more farmers should attempt the difficult job of breeding. More breeders and fewer mere multipliers of stock is, in Prof. Rae's opinion, a sound maxim for the future.

The rest of his address develops this theme by interesting and valuable summary and comment upon some of the schemes which seek, at present, to improve dairy cattle and pigs in Great Britain. How many people, one wonders, when they get their loaves and bacon and bottles of milk, are aware of the vast organization, the immense labours of mind and muscle and the complex organization and machinery which combine to deliver them at their doors? More than one book has been written about the marvellous organization which delivers at our doors the daily newspaper; and marvellous that organization is: but how much greater, how beneficent and how poorly appreciated are the miracles daily done on the English farm.

Among contributors to the instructive discussion which followed this address were Colonel E. M. Curley, chief veterinarian, European Theatre of Operations, United States Army, and Dr. Tj. Bakker, who gave interesting accounts of some aspects of veterinary work in the United States and Holland.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, January 22

BIOCHEMICAL SOCIETY (at the British Postgraduate Medical School, Ducane Road, Shepherds Bush, London, W.12), at 11.15 a.m.

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (joint meeting with the MIDLAND BRANCH of the INSTITUTE OF PHYSICS) (at the University, Edmund Street, Birmingham), at 2.30 p.m.—Discussion on "Space-Charge and Noise in Radio Valves" (to be opened by Dr. P. B. Moon and Dr. R. R. Nimmo).

Monday, January 24

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—"The British Arctic Air-Route Expedition, 1930–31"; Geographical Films with Commentary by Members of the Expedition.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Industrial Applications of Radio-Frequency Methods of Heating" (to be opened by Mr. N. R. Bligh).

Tuesday, January 25

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Miss Olive Lodge: "Folk Festivals in Jugoslavia".

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Prof. D. B. Johnstone-Wallace: "Mechanisation of the Family Farm".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 4.15 p.m.—Dr. Donald Hunter: "The Clinical Approach to Industrial Medicine".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5 p.m.—Mr. H. D. Morgan: "Wharves on Soft Foundations".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. D. Kay: "Modern Developments in Dairy Science". i. "Milk and Milk Products as Foods".*

Wednesday, January 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. R. N. Armfelt: "Education To-day and To-morrow", 3: "Primary Schools".

PHYSICAL SOCIETY (COLOUR GROUP) (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Dr. T. Vickerstaff: "Some Difficulties encountered in applying the Theory of McAdam's Limiting Brightness to Real Dyestuffs".

Thursday, January 27

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "The Strategy and Tactics of Crystal Structure Analysis by X-Rays".*

ROYAL SOCIETY OF MEDICINE (at Manson House, 26 Portland Place, London, W.1), at 4 p.m.—Dr. W. Norwood East: "Criminal Responsibility and Medical Culpability".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Mr. F. E. Lane: "Special Electron Tubes".

Friday, January 28

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir Harold Spencer Jones, F.R.S.: "Measuring the Sun's Distance".*

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. G. S. Baker: "Fundamentals of the Marine Screw Propeller" (Sixteenth Thomas Lowe Gray Lecture).

Saturday, January 29

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 2.30 p.m.—Symposium on "Microdensitometry and Microsensitometry"

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEADMASTER of the Junior Technical School—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (January 27).

EDUCATIONAL PSYCHOLOGIST (full-time)—The Secretary for Education, Education Offices, York (January 28).

ASSISTANT MASTER to take ADVANCED MATHEMATICS as the main subject and PHYSICS as a subsidiary subject, and an ASSISTANT MASTER to take MECHANICAL AND ELECTRICAL ENGINEERING SUBJECTS—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex (January 28).

SPEECH THERAPIST to serve the Crewe and Cheshire Education Committees jointly—The Director of Education, Imperial Chambers, Prince Albert Street, Crewe (January 29).

HEAD OF THE ENGINEERING MANUFACTURE AND TRADES COURSE SECTION of the Department of Mechanical Engineering—The Principal, Central Technical College, Suffolk Street, Birmingham (January 31).

HEAD OF THE MINING DEPARTMENT at the North Staffordshire Technical College, Stoke-on-Trent—The Clerk to the Governors, Education Offices, Town Hall, Hanley (January 31).

ORGANIZER OF AGRICULTURAL EDUCATION to the East Suffolk County Council Education Committee—The Secretary for Education, County Hall, Ipswich (February 1).

PRINCIPAL of the Gloucestershire College of Domestic Science and Training College—The Secretary, County Education Office, Shire Hall, Gloucester (February 5).

DEMONSTRATOR (man or woman) in the Department of Zoology—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (February 5).

QUALIFIED ENGINEER for the development of Light Alloys, their utilization in fabricated form, the investigation of technical problems arising out of current applications and research into new applications, in the North-Western Area—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.1962.XA) (February 5).

HEAD MASTER—The Clerk to the Governors, Sir Joseph Williamson's Mathematical School, 116 High Street, Rochester (February 12).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

WORKS ENGINEER for Non-Ferrous Metal Producing Plant in South Wales—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C. 1944.XA).

HYDROGRAPHICAL SURVEYORS for the Basrah Port Directorate, Iraq—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O.4862.S.).

ASSISTANT PHARMACIST for the Tanganyika Territory Medical Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1218).

MATHEMATICS MISTRESS (honours degree) at the English High School, Haifa—The Secretary, Jerusalem and the East Mission, 8 St. Thomas Street, Winchester.

Two full-time ASSISTANT TEACHERS for (a) SCIENCE and/or MATHEMATICS; and (b) GENERAL TECHNICAL SUBJECTS including WOODWORK or METAL WORK—The Principal, County Technical College, Stoke Park, Guildford, Surrey.

LECTURER IN MECHANICAL OR ELECTRICAL ENGINEERING, and a SCIENCE LECTURER—CHEMISTRY and/or PHYSICS, with subsidiary Mathematics, at the Swansea Technical College—The Director of Education, Education Department, Guildhall, Swansea.

ASSISTANT CHEMIST and an ASSISTANT PHYSICIST—The Director of Research, Linen Industry Research Association, The Research Institute, Lambeg, Co. Antrim, Northern Ireland.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The J. and P. Scheme of Apprenticeship Training in Engineering. (Publication G.1.) Second edition. Pp. 12. (London: Johnson and Phillips, Ltd.) [2412

Proceedings of the Royal Society of Edinburgh, Section B (Biology). Vol. 62, Part 1, No. 1: On *Isoetes australis* S. Williams, a New Species from Western Australia, Part 1: General Morphology. By Dr. Samuel Williams. Pp. 8+3 plates. 9*d*. Vol. 62, Part 1, No. 2: Hidden Divergence in Laboratory Strains of *Drosophila pseudo-obscura*. By Rowena Lamy. Pp. 9–19. 1*s*. Vol. 62, Part 1, No. 3: Genotypic Asymmetries. By Dr. Gunnar Dahlberg. Pp. 20–31. 1*s*. (Edinburgh and London: Oliver and Boyd.) [2412

Colonial Research Committee. Progress Report, 1942–1943. (Cmd. 6486.) Pp. 26. (London: H.M. Stationery Office.) 6*d*. net. [2812

Ministry of Health: Emergency Medical Services. Memorandum No. 6: The Organisation of a Hospital Rehabilitation Department. Pp. 10. (London: H.M. Stationery Office.) 2*d*. net. [3112

Geological Survey of Great Britain: Scotland. Wartime Pamphlet No. 36: Peat Deposits of Scotland, Part 1: General Account. By Dr. G. K. Fraser. Pp. 55. (London: Geological Survey and Museum.) 2*s*. 6*d*. [41

Other Countries

Sudan Government. Wellcome Chemical Laboratories: Sudan Medical Service, Khartoum. Report of the Government Analyst for the Year 1942. Pp. 16. (Khartoum: Wellcome Chemical Laboratories.) [2412

Smithsonian Institution: United States National Museum. Bulletin 183: Archeological Investigations in Platte and Clay Counties, Missouri. By Waldo R. Wedel; with Appendix: Skeletal Remains from Platte and Clay Counties, Missouri, by T. Dale Stewart. Pp. viii+284+50 plates. (Washington, D.C.: Government Printing Office.) 1 dollar. [2412

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ended June 30, 1942. (Publication 3705.) Pp. xiii+421+83 plates. (Washington, D.C.: Government Printing Office.) 1.50 dollars. [2412

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 164: Studies in the Biology of the Skin and Fleece of Sheep. 1: The Development and General Histology of the Follicle Group in the Skin of the Merino; 2: The Use of the Tanned Sheepskin in the Study of Follicle Population Density; 3: Notes on the Arrangement, Nomenclature and Variation of Skin Folds and Wrinkles in the Merino. By H. B. Carter. Pp. 60+16 plates. Bulletin No. 166: Fertility in Sheep; an Experimental Study of Periodicity of Oestrus and Non-breeding Seasons in Australia. By Dr. R. B. Kelley and H. E. B. Shaw. Pp. 28. (Melbourne: Government Printer.)

NATURE

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COLONIAL RESEARCH AND DEVELOPMENT

THE Colonial Research Committee appointed in June 1942 to advise on the expenditure of the £500,000 a year provided by the Colonial Development and Welfare Act, 1940, for the promotion of research and inquiry in matters affecting the Colonies and to advise upon and co-ordinate the whole range of research in the Colonies, has now presented a progress report on its first year's work, 1942–43*. The report includes an account of developments leading to the establishment of the Committee, the functions of which were outlined by Mr. Harold Macmillan in a statement to the House of Commons on April 28, 1942 ; the first interim report of the Colonial Products Research Council, constituted under the chairmanship of Lord Hankey in January 1943, is appended (see p. 133 of this issue), together with lists of Colonial agricultural institutes, medical research institutes, schools of medicine and veterinary research stations, centres for the collection, distribution and interchange of scientific information on agriculture and medicine, supported jointly by all countries of the British Commonwealth, and particulars of research schemes under the Colonial Development and Welfare Act, 1940, prior to the establishment of the Committee. The report of the Colonial Research Committee is signed by Lord Hailey as chairman, and it is proposed to present an annual report in April in future, that is, at the end of the financial year.

This first report shows an outlook which in itself indicates how wise was the decision to establish the Committee. and also the immensely important contribution to Colonial development and welfare which the Committee will be able to make if adequately supported. The preparatory work described in the Report shows that the Committee has started on the right lines. It has already indicated certain general features of Colonial research that require early attention, and the wide view of its functions taken by the Committee should be all the more fruitful when, after the War, the prosecution of extended schemes of research becomes possible.

The Committee accordingly has not limited itself to the examination of proposals laid before it by Colonial Governments or by other bodies. It has conceived it as its duty to study the whole field of scientific inquiry ; to distinguish the parts of it requiring attention, and to ensure that gaps in it are filled wherever possible. In accordance with this conception of a planning commission for the whole field of Colonial research, the Committee has first limited itself to a preliminary survey of the special problems and needs of Colonial research as a whole, and to an examination of the general principles which should be followed in its organization. Comprehensive planning of future developments now will enable the Government the better to put schemes of research into operation as soon as scientific men and others now engaged in war duties are free to participate in Colonial development.

* Colonial Research Committee. Progress Report 1942–1943. (Cmd. 6486.) Pp. 12. (London : H.M. Stationery Office, 1943.) 6*d*. net.

Naturally enough, the Committee has not yet been able to complete its survey of the major subjects which must come under its review. Its first task has been to form an estimate of the character of the research work already undertaken in the Colonial territories. On this point the Committee, while impressed with the efforts that have been made by research workers in these territories, often in the face of great difficulties, and with the value of many of the results achieved, is convinced that scientific facilities and terms of service must be improved, and new or additional methods of recruitment and organization devised if research is to play an effective part in the development of the Colonies. The isolation of the research worker in the Colonies from fellow-workers in his own, or in kindred, fields of science is one fundamental difficulty. Again, in some Colonies, the shortage of technical staff has obliged research workers to give much of their time to routine work, and even if they are freed from the pressure of routine work, there is a tendency for research problems to be defined too exclusively by local and temporary interests, without due regard to scientific possibilities, or to the scale on which a given investigation must be planned if it is to have any reasonable hope of success.

Under such conditions there will always be difficulty in attracting the ablest research workers to the Colonies, and the Report rightly stresses the necessity of obtaining men and women of outstanding ability in order to make Colonial research effective. To meet these difficulties, the Committee recommends, first, that further attention be given to the special conditions of service of research officers. Of these, the most important is greater freedom of exchange between universities and institutes in Great Britain, in the Colonies, and in other countries where similar research problems are being studied. Study-leave would mitigate the isolation of the Colonial research officer, but by itself is not enough. The Committee suggests that it is worth considering the possibility of establishing separate research services under some central organization in the United Kingdom, possibly the Colonial Office, which would provide a pool of scientific workers on which Colonies could draw.

Both this proposal and the allied suggestion of the formation of a sort of 'scientific volunteer reserve' of workers normally employed in independent institutions reflect the spirit which has animated the recent proposals for the reform of the Foreign Service, but their implementation will involve attention to such conditions of service as salary scales, pensions and the like, and the elimination of anomalies. Equally, they cannot be considered in isolation from the discussion of the status and remuneration of the research worker generally, which has been initiated by recent reports on industry and research. Colonial research, whether from the point of view of staff or organization, must, in the final issue, be planned as part of an imperial policy of research.

A second means suggested by the Committee of mitigating the isolation of the research worker in the Colonies is the development of centres of research and learning in the Colonies themselves. The Committee has been in touch with the Higher Education Sub-Committee of the Advisory Committee on Education in the Colonies, which has been studying the possibilities of developing facilities for research in such bodies as the Universities of Malta, Jerusalem, Ceylon and Hong Kong, and institutions which may prove to be the nuclei of future universities, such as Raffles College at Singapore, Makere College in East Africa, and Achimota and Yaba Colleges in West Africa. An increase in research facilities at these centres would raise the standard of learning in these nascent universities, and do much to remove the sense of isolation at present inseparable from Colonial research.

In regard to the organization of research, the Report emphasizes the need for an extended range of research. The investigations so far undertaken have been directed mainly to subjects involving problems of immediate importance. Commercial undertakings have played a large part in the development of research which has been of direct interest to them. Inquiries of great importance have probably been postponed because they do not fall within the purview of the main Colonial departments, and basic surveys, either topographical or geological, do not exist in many Colonies. Few systematic studies of the flora and fauna of Colonial areas have yet been undertaken, and more detailed investigations of the species of fish living in local waters and their life-histories are indispensable for the further development of fisheries in the Colonies. Ethnological and linguistic surveys are lacking in some areas, as well as data on social and economic conditions, and much remains to be done in the field of vital and census statistics.

For such reasons the Committee considers that an important use of the funds now available will be the extension of the scope of investigations to be undertaken in the Colonies, especially in the poorer territories. By making it possible to organize long-term and short-term basic surveys and to promote research on general environmental problems as well as in the whole field of social research, the new financial provision should do something to meet a further difficulty encountered in the past in the lack of continuity of research. Full value cannot be obtained from research unless continuity is ensured, and one of the main advantages of the new provision of funds under the Colonial Development and Welfare Act is to secure such continuity.

Next, the Report points to the need for central and regional organization, not only to achieve the most economical use of the slender resources of research workers and equipment available, but also as the easiest way of securing that co-ordination between the different fields of research which is necessary if comprehensive investigations are to be made of specific problems, especially those related to development programmes. Machinery for securing the co-ordination of different types of research is particularly important at the present stage of development of the Colonies, and it is well to remember that the frontiers of scientific research do not coincide with political boundaries. Co-ordination of work to be carried out jointly in several Colonies or in Colonial

territories and those of neighbouring Dominions or of other States may be necessary; but in discussing the question of Government control of Colonial research, the Committee emphasizes the necessity of seeking the greatest elasticity in the organization of research. Generally, it should be so organized that Government investigations and those conducted by academic or other bodies go on freely side by side.

In addition to these general conclusions, the Committee has reached a number of conclusions in regard to particular fields of research so far surveyed. The Committee accepts the proposal of the Colonial Survey and Geophysics Committee that topographical and geodetic surveys should be planned by a central Colonial survey organization, and recommends the preparation of a detailed scheme for such an organization, so that the necessary plans can be put into operation at the end of the War when men should be available. Similarly, it recommends the preparation without undue delay of detailed proposals for an extension of Colonial magnetic and meteorological services, in view of their importance to mining developments, to agriculture, and to wireless transmission and radio navigation. A scheme of this kind is also being considered by the Colonial Survey and Geophysics Committee.

The Committee's review of the facilities for forestry research has led to the conclusion that the central organization of Colonial forestry research is already adequately provided by existing organizations, but regional centres will be necessary in the Colonies for research into forest products, and in most Colonies the staff concerned with entomological research and sylviculture should be considerably increased. The importance of research into the systematic classification of Colonial fishes and the study of their life-histories has already been indicated, and, stressing the economic importance of Colonial fisheries and its bearing on nutrition, the Report also points to the need for investigations into methods of fishing, of preserving and processing fish, as well as on the marketing and transport of supplies. For this purpose further marine fisheries research stations are required, especially in the West Indies, West Africa and East Africa. In addition to extension of the existing fisheries departments of Ceylon, Malaya and Hong Kong, establishment of a regional research station for freshwater fisheries in East Africa is suggested.

The Committee received a survey of the present position of agricultural research in the Colonies approved by the Advisory Council of Agriculture, Animal Health and Forestry, and reviewed the progress in the organization of agricultural research since the recommendations of the Imperial Agricultural Research Conference in 1927 and the two Lovatt Committees on Agricultural Research and Administration in the Colonies in 1927 and 1928. It is considered essential that research work on a full scale should be resumed at Colonial centres as soon as possible, with such measures of reorganization and extension as may be necessary to cope with post-war development. In addition to further provision of staff and facilities for research on the cytological side of plant genetics, on plant physiology with special reference to plant disease, on virus diseases of plants, and on trace elements, on the control of insect pests by biological means and by the use of insecticides, and on insect pests of stored products, etc., the importance of planning agricultural research in line with modern views of agricultural policy as reflected in the pronouncements at the United Nations Conference on Food and Agriculture at Hot Springs is stressed. A policy of raising the standard of living of Colonial peoples and particularly their standards of nutrition involves co-ordinated schemes of land utilization surveys, forestry research, experiments in methods of improved cultivation in backward areas by the introduction of better strains of crops and mixed farming systems suitable to local conditions, improved storage, grading and marketing and a co-ordinated policy for improving human and animal nutrition; for such planned development the closest interdepartmental co-ordination will clearly be necessary.

While medical research has not been considered by the Committee in any detail, its survey of the position of veterinary research has led to agreement that regional research centres in animal health are required for each group of territories, with, if necessary, separate laboratories for the production of biological preparations. Each Colony should also have a small laboratory for the study of its own local problems and its own pathological work. Again, while in the initial stages veterinary research in the Colonies should be directed towards the control or elimination of the most destructive diseases of stock, this must be followed by research directed towards the improvement of livestock with a view to the maintenance of healthy and productive herds to supply the nutritional and economic needs of the Colonial peoples. For this purpose, research on animal health requires organization on a wider basis, and the inquiries involved will call for the co-operation of teams of workers in different scientific fields.

Finally, in regard to the neglected field of the social sciences, in the absence of appropriate organizations, the Committee has sought the advice of groups of experts in linguistics; demography, anthropology, and social surveys; economics; systems of colonial law; colonial administration; and education and psychology. The organization of research in the social sciences will be considered further on the basis of the reports of these groups. The Committee is also taking every opportunity of establishing contact with interested individuals and organizations in other countries, and particularly with those within the British Commonwealth. It has also recommended the establishment of Colonial research fellowships, so as to build up a cadre of young men and women familiar with colonial scientific problems and able to help in their solution; and it may be of value to finance occasional pieces of research by senior scientific workers holding academic or other research posts.

There can be no question as to the importance of the work to which the Colonial Research Committee has addressed itself, both from the point of view of implementing the new colonial policy and realizing

the hopes aroused by the Hot Springs Conference. It has a close bearing on the whole question of world trade and full employment policy, and the Committee rightly makes it plain how closely the first steps are dependent on man-power. This Report deserves not only the close attention of scientific workers but also careful study by all those bodies concerned with demobilization, such as the interdepartmental committee under Lord Hankey to ensure the relation of training and educational facilities to prospects of employment at home and abroad and to university development and reorganization. The basic problems of colonial research and their implications are fairly stated, and scientific workers must not shirk the responsibility of seeing that the appropriate action is taken or of facilitating the difficult task of securing the large amount of co-operation which in such fields as agriculture and animal health is as indispensable a condition of scientific as it is of social and economic advance.

THE HOUSE OF MACMILLAN

The House of Macmillan (1843–1943)
By Charles Morgan. Pp. xii+248. (London: Macmillan and Co., Ltd., 1943.) 8*s*. 6*d*. net.

IT was on November 10, 1843, that two young Scottish booksellers, Daniel and Alexander Macmillan, published their first book, "The Philosophy of Training", by A. R. Craig, late classical master in Glasgow Normal Seminary. They were setting up a bookselling business in Cambridge (now that of Messrs. Bowes and Bowes), but they had other ambitions, "to realize some of their ideals" by publishing good books—and their London office at 57 Aldersgate Street was the first step towards their establishment as one of the greatest of publishing firms. Both had youthful experience with booksellers and publishers, and in the main had educated themselves; but they made the acquaintance of Archdeacon Hare, and through him of F. D. Maurice; in Cambridge, customers, young and old, became friends, with lasting respect and affection, and their rooms became a centre of serious discussion, social and theological. Alexander did much for the Working Men's College in Cambridge; Daniel defended Maurice in private and in public. Meanwhile, authors multiplied and books appeared, some of them still in service, such as the translation of Plato's "Republic" by Davies and Vaughan. Of the early authors, best known are Charles Kingsley, and Tom Hughes, whose "Tom Brown" had immediate success. Daniel had never been strong, but his wise counsel was a mainstay until his early death in 1857; and one of his projects, the London branch at 23 Henrietta Street, Covent Garden, was realized soon after, with a similar club-like appendage, where 'Tobacco Parliaments' attracted an increasing number of guests—poets, historians, men of science, and story-tellers, among them Tennyson, Huxley, Dicey, Palgrave, and Herbert Spencer.

These were the notable beginnings of an enterprise which has more than justified them. The story of it is a remarkable cross-section of the literary and intellectual world of the Victorian age, so strenuous and serious in pursuit of many divergent aims, but behind its colossal gravity so intensely human. There is a distinction in degree, rather than in kind, between biography and history; and when biography deals with a family, and with two or three generations, as here and in the recent "Time and Chance" of Dr. Joan Evans, the distinction begins to fade. When it also deals with a corporation, and with the profession which it subserves, it almost disappears, unless the personalities are unusually forcible and congenial. On the other hand, the more significant the narrative, as an illustration of contemporary notions and trends, affecting those persons as well as affected by them, the closer does the work come to strictly historical writing. Few recent books have given so vivid and wide a glimpse into the cultivated life of London during the last hundred years, or brought so many portraits into one 'conversation piece' describing the setting of their common interests and pursuits; or analysed so critically the institution which interconnected them, as well as the persons who created and maintained this common bond; the combination of business ability, critical judgment, and personal humanity which gives a publisher's life its opportunities and its rewards, in fame and in friendship.

Being eminently business-like men, the Macmillans have kept ample record of their doings, their experiences, and their thoughts; and Mr. Morgan has evidently had liberal access to these archives; even in Daniel's frequent absences through ill-health, Alexander's copious correspondence with him preserved unusually intimate detail for the earlier years. As their business grew, they all became more dependent on critical reports from trusted and experienced advisers, among whom John Morley was the most eminent, and is the most often quoted. Later, the long memories of loyal retainers add picturesque detail and wholesome atmosphere to the written records: good masters are well served. But it is clear that many important decisions were taken on personal impressions of one or more of the partners, as well as on their reading of manuscripts. Especially was this so in early days, when authors like Maurice, Kingsley and Hughes were their personal friends, and others, afterwards famous, were the contemporaries or the juniors of the head of the firm, himself still in the forties. That is the significance of the letters quoted here, to men like Hardy, or Rossetti, or Watt; of the design on the cover of so many Macmillan books—"the stars for heavenly light and glory, the acorns for earthly growth and strength, the tree for useful industry, the butterfly for beauty pure and aimless"; of the invention—for it was no less—of the "Golden Treasury", the "Globe Shakespeare" and its companions, and the "English Men of Letters" series. As Mr. Morgan writes of publishing generally, "its character certainly, and perhaps even its romance, may be more truly said to arise from its sharp intermingling of calculation and industry with intuition and mere chance". In no calling does so much depend, as in publishing, on the character and judgment of the publisher.

On more than one occasion, by its grasp of principle and obstinate adherence to policy, the house of Macmillan rendered public service to everyone concerned in the production and distribution of books. Of these the most important in retrospect were the discussions of literary copyright, from Alexander Macmillan's letter to Sir John Coleridge on July 30, 1873, to the new Copyright Act of 1911, in the framing of which Frederick Macmillan had a share; the Net Book Agreement between the publishers and

the booksellers achieved after long negotiations in 1899; and the consequent 'Book War' with *The Times* Book Club in 1906–8, in both of which he was again in a leading part. Now that this ferocious struggle is long over, it is possible to put the whole matter in an impartial and historical way, and Mr. Morgan has done this well.

Another great service was the publication of English classics, and also modern books such as Morley's "Life of Gladstone" in popular but well-printed editions for a few pence a volume or part. It takes its place in the same historical perspective as the University Extension Movement, and the copious supply of elementary text-books by first-rate authorities, especially in classics and in natural science, for a new and very wide public in the secondary schools. Mr. Morgan gives examples of the great care taken personally by members of the firm, and especially by Maurice Macmillan, in the selection and—one may almost say—the training of authors, in this important branch of literature.

Very fortunately, as its business widened, the House of Macmillan was able to supply within the family circle a succession of able men, each moreover with a contribution of his own. In the general conduct of affairs, Frederick Macmillan's versatile and thorough acquaintance with the technique of printing and bookselling, and his long residence and family ties in North America, made him the natural successor to his uncle Alexander. Maurice, hard-headed but as fertile in ideas as any of his brothers, "carried the unspectacular but important responsibility of the firm's educational department" already mentioned, and out of this developed the large business with India, which had engaged Alexander's attention long before, on its educational side, and profited by the wise experience of Sir Roper Lethbridge of the Bengal Educational Service. The policy was the same as at home, "to get the very best men in each kind of knowledge to write the most elementary books", but they had to be written to meet Indian needs and conditions, and Maurice's long journey in 1884 was a real contribution to the advancement of education in India.

George Macmillan, a King's Scholar at Eton, who had learned to love Greece with Mahaffy, brought wide unacademic insight into many aspects of classical scholarship, dealt with such portentous growths as Frazer's "Golden Bough" and Arthur Evans' "Palace of Minos at Knossos", founded and long directed the Hellenic Society and (with Walter Leaf) was the earthly providence of the British School of Archæology at Athens, honorary secretary of the Royal College of Music, an active member of the Society of Dilettanti for which the famous "Antiquities of Ionia" were completed at last: and he could take a hand both in Groves' "Dictionary of Music and Musicians" and in the "Cambridge Natural History", examples of the "long-term publishing" characteristic of the House throughout. If his "austerity on duty" was "a little intimidating" to the young, the intense devotion of this precise ascetic-looking Olympian to 'unpractical' but remunerative enterprises was a peculiar stimulus until the man himself was revealed.

Less easy to assign is the responsibility and the credit for the firm's record in the advancement of natural knowledge by many great text-books, and above all by the publication of NATURE. "The risk was not small" and it was nearly thirty years before it "began at last to pay its way" as an "intelligence service" among men of science themselves, as well as for the public. It was its peculiar good fortune to have had only two editors between 1868 and 1938, namely, Sir Norman Lockyer (1868–1918) and Sir Richard Gregory (1918–38) (see also NATURE of February 27, 1943, p. 231), whose eightieth birthday is celebrated on January 29 (p. 133).

It is only possible to select from Mr. Morgan's intimate and congenial retrospect the more conspicuous achievements, and some indications of the principles and policy on which they were based. But it is the humanity, the personal enthusiasms and convictions, which make the record so significant. From the first, the Macmillans "did their best to realize some of their ideals" by publishing good books by the right people. Long may they continue to do so. JOHN L. MYRES.

PSYCHOLOGY OF INTERNATIONAL PEACE

Conscience and Society

A Study of the Psychological Prerequisites of Law and Order. By Dr. Ranyard West. Pp. iv+260. (London: Methuen and Co., Ltd., 1942.) 15*s*. net.

IT is very important that psychologists should play their part in the affairs of post-war years, and especially in the coming attempt to establish international peace on a sure footing. They must show that they have a genuine contribution to make, and that they are capable of making it in a way which can be understood and utilized by people without the psychologist's special training. It must be a clear and simple contribution, to the point and free from disabling controversy. It must show the wisdom and restraint which come from a deep insight into life and experience.

On account of these needs we are grateful to Dr. Ranyard West for his book "Conscience and Society". He has presented, in serious and scholarly manner, arguments which show at least some of the essential factors in the great problem of establishing international peace. There are, in his opinion, two major groups of impulses in mankind which are related to this problem. They are the social and the self-assertive or aggressive instincts. The social or co-operative instinct he believes to be normally uppermost, and it seems to him the main impulse behind our daily comradeship. The aggressive instinct is biologically understandable as providing each individual with the impulses of self-defence and self-assertion; but in his view of human nature, it is more like a reflex occasionally aroused than like an appetite in need of periodical gratification. A third force operates in man's social life, namely, conscience, and this, according to Dr. West, is the fear of the loss of the love of our fellow-men through the self-interested expression of our own assertive and aggressive impulses. This conscience supports the social against the aggressive urge, and helps to preserve peaceful and constructive social relations.

Every individual, however, is liable to outbursts of personal aggression, and those who are neurotic owing to the persisting after-effects of infantile and childish disturbances of emotion are peculiarly liable to such outbursts. Hence external control, government and law are needed to strengthen conscience and enforce its demands in moments of weakness. In this respect groups and nations are comparable with individuals. Their goodwill depends

on circumstance, and their loyalty to ideals of international peace depends on the vagaries of the self-interest of national and sovereign powers.

Thus, in the establishment of world peace, nationalism and the self-interest of sovereign States, which are always potentially aggressive in self-defence, must be given second place to an international organization the function of which will be to control and arbitrate. It must be able to do this without national self-interest, but impartially in the cause of peace, just as, in individual relationships to-day, justice can be carried out with a wisdom which is independent of personal bias and prejudice. Social philosophers, such as Hobbes, Locke, Rousseau and Freud, seem to have viewed man's problems as if reflected by their own personal fears and peculiarities of character. Dr. West points this out and tries to take a truly objective view.

Easy though it might be to criticize Dr. West's book, it would not be easy to destroy its essential meaning. The scheme of two instincts, a 'good' and a 'bad', of which the 'good' is the usual winner, supported by a generally beneficent 'conscience', are excellent as the basis for the exposition of his theme, the importance of which cannot be denied; but this scheme is not sufficient to account for the complexities of life as we know them, and could never form the foundation of social psychology for a deep thinker. The book is overloaded with criticism of other writers, especially Freud, on whom, nevertheless, Dr. West leans very heavily. The shortcomings of Freud's genius are too clear to need such meticulous underlining. The author lays too much stress on the study of obsessional neuroses, and he appears to overlook the part played by psychotic tendencies in group and individual battles and misunderstandings. It seems strange that so experienced a psychologist should think that internal mastery and external control are the only ways of dealing with selfish aggression in group or individual. He does not realize the vast extent to which constructive social life itself depends on the proper use of individual aggression.

These objections, and others which might be made, however, are only asides in a review of so estimable and sincere a work, and can be forgotten in our gratitude to Dr. Ranyard West for giving us a book which is a valuable pointer in one of the directions in which psychology can contribute to the future welfare of mankind. A great merit of the book is that its author has attempted to bring together social philosophers, legal authorities and psychologists in his effort to help in the solution of what must be for them a common problem.

R. W. PICKFORD.

THEORY OF THE TRANSMISSION OF VERY SHORT RADIO WAVES

Microwave Transmission

By Prof. J. C. Slater. (International Series in Physics.) Pp. x+309. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1942.) 24s. 6d.

DURING the past ten years or so the published radio technical literature has contained the descriptive results of many investigations into the nature, properties and possible applications of the very short electric waves resulting from the generation of oscillations at frequencies greater than 100 megacycles per second. While the best mode of designating these frequencies and the corresponding wave-lengths is a very controversial matter, one general term is frequently applied, namely, 'microwave'. Any possible misunderstanding as to the scope of the book under review is removed at the start by the author who, in the first sentence of the preface, states that "Microwaves are electromagnetic waves of wave-lengths that we may take, for definiteness, to be between 1 centimeter and 1 meter". It is then pointed out that these waves are unique in the whole range of electromagnetic waves, in so far as the wave-length is of the same order of magnitude as the dimensions of ordinary laboratory apparatus, a feature which makes possible the use of experimental methods differing markedly from those used formerly in radio-frequency technique.

Prof. Slater's book deals with the general principles and fundamental theory underlying the transmission of these short radio waves from point to point, without being concerned with the problems of generation and reception. Microwave problems differ from ordinary circuit problems, in that it is no longer valid to deal with lumped impedances, but thought must be centred on the distribution of the inductances and capacitances around or along the circuit. In addition, conductors in the microwave region are very different from the open-wire circuits used at longer wave-lengths, since such circuits would lose too much energy by radiation to form useful transmission lines. These lines take the form of co-axial cables, consisting of a rod carried concentrically within a hollow pipe, or even of the hollow pipe alone.

From these considerations the book opens with a chapter on the theory of transmission lines, viewed as an electrical network; and then proceeds in Chapter 2 to a discussion of Maxwell's equations, and the production and properties of plane electromagnetic waves. This leads naturally to consideration of the propagation of electromagnetic energy along rectangular wave-guides, and to the general problem of transmission lines when these are hollow conductors. So far the work is confined to the study of disturbances propagated along one definite direction, but when the transmission line or wave-guide terminates in an antenna in free space, the resulting radiation will be emitted in all directions. Chapters 5 and 6 therefore deal with Maxwell's equations in spherical co-ordinates and with the principles of the various directive devices used with antenna systems for very short wave-lengths. The final chapter in the book deals with the coupling of coaxial lines and wave guides, considering particularly the problem of radiation and absorption from a dipole inside a rectangular wave-guide.

Altogether the author would appear to have attained his objective of producing "a book of an intermediate range of difficulty". While an extensive mathematical knowledge is not assumed, some acquaintance with classical electromagnetic theory and Maxwell's equations is necessary, and the work should present little difficulty to the first-year graduate student in physics or electrical engineering, or to the senior worker with a good training in electricity. In view of the extensive application at the present time of the range of wave-lengths covered by the book, this should be found of great interest to many workers and students, even though it does not deal with practical or experimental technique.

UNIFICATION OF BOTANICAL SCIENCE

By PROF. C. W. WARDLAW
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"Botany is the science which treats of plants."
—*Oxford English Dictionary*.

"Every speculation about a single phenomenon wrenched from the continuity of life, is playing indeed a thankless part in the present condition of the natural sciences."—SCHLEIDEN, 1838.

"An unflinching determination to take the whole evidence into account is the only method of preservation against the fluctuating extremes of fashionable opinion."—A. N. WHITEHEAD, 1926.

"An upward outlook is in itself a practical application of any evolutionary view."—F. O. BOWER, 1935.

ANY biological phenomenon can be considered from several different points of view, each of which may lead to the formulation of particular and distinctive concepts. In some instances concepts relating to different aspects may overlap: in other instances they may belong fundamentally to different categories. Now, it is a fact that botanical science has developed erratically and spasmodically; botanists have embraced strange and irreconcilable philosophies; they have welcomed innovations and canalized them into fashions or moulded them into new branches of the science. Moreover, the results forthcoming from the several distinctive phases have not invariably been studied with due regard to their mutual relationships, nor have they necessarily been envisaged as contributing directly to a generalized scheme. The piecemeal character of the scientific advance and the diversity of its branches of underlying philosophy have increased notably during the last fifty years; for it has been a period of great, if non-co-ordinated, activity along many seemingly divergent lines of inquiry. Cogent reasons, therefore, exist for the view that the time is at hand when an effort should be made to achieve some closer integration of the science as a whole.

As a result of the growing volume of research on almost every branch of botany and the concurrence of certain contemporary lines of investigation, there is a reasonable hope that certain gaps that have hitherto hindered synthesis may in due course be bridged and that this may lead towards a real unification of outlook. To some, no doubt, this may appear as unjustifiable optimism. The question may indeed be asked why this topic is considered to merit special attention at the present time. It may be argued that botanical science does not in fact lack unity, that it has been adequately unified at various times in the past, or that complete unification is difficult or even impossible. Moreover the nature of the unification envisaged itself requires elucidation: What kind of unification and for what purpose? I have in mind both the conceptual and methodological aspects: the former is concerned with general questions, that is, possessing significance for the plant kingdom as a whole; the latter considers the results of a particular discipline in relation to those of all other relevant disciplines, instead of such results being treated in comparative isolation. It is this latter aspect of unification that I consider of particular importance at the present time.

It seems evident that failure to achieve some progressive method of integration in the near future will be attended by such an accumulation of non-co-ordinated data as to dismay contemporary botanists and bewilder their successors. There is no novelty in this view, but emphatic reiteration seems timely. In the long view, teaching and research are inseparable; failure to collate the main results of contemporary and past work will certainly militate not only against reasonable advance but also impede the proper teaching of the subject.

In the realm of biological science, where a sense of ever-increasing complexity appears to be the chief reward of the most profound investigations, the less complicated structure and mechanism of plant life, as compared with animal life, might be expected to afford a more direct approach to the fundamental problems of organic Nature. Hence an unbiased observer might take it for granted that botanists would automatically take the lead in the formulation of new concepts and the enunciation of broad generalizations. Reference to some recent works on general biology can scarcely be considered to support this view; indeed, a certain neglect of botanical work is apparent by adherents of other branches of biology. It may be that botanists are to blame; for while collectively their science abounds with new and impressive discoveries, it may be argued that these have not been presented in such a way as to be readily accessible to the general reader. The justification for seeking to co-ordinate the various branches should lie not only in its desirability on philosophic grounds but also in its results. Past prophecy as to the future direction of scientific achievement has not enjoyed such a success as to encourage present attempts, but it seems evident that a period of great synthetic development is on its way. This potential development, however, will only become actual if a synthesis, dynamic and progressive, of all new knowledge is steadily maintained in some reasonably accessible form. Thus a contributory channel of specialized research would be seen not only in relation to neighbouring channels but also to the course of the main stream.

Botany and the Botanists

"Botany is the science which treats of plants" (*Oxford English Dictionary*), and in an extended definition is usually understood to include a consideration of their growth, development and reproduction, the functions of their organs, their origin, systematic affinities, geographical distribution and relation to their environment. Some years ago Prof. W. Stiles indicated that in his view there could be no such thing as a *general botanist*: that an investigator may take a sympathetic interest in other branches of the science and realize the bearing of such work on his own, but that the latter, in these days of specialization, must necessarily lie in one particular field. Clearly in such a statement there is ground both for agreement and dissent. In so far as an investigator fails to realize the relation of his work to the science *as a whole*, so may he fail to appreciate the actual and potential development of the subject in his time.

What, then, do we hope to make of "the science which treats of plants"? What, in particular, is to be the relationship of the specialized branches, for example, plant biochemistry or genetics, to the parent science?

The last five decades have witnessed a great expansion of botanical research in the course of which new aspects, each requiring detailed investigation by means of special technique, have become distinct, specialized and almost separate branches of

biological science. To-day, a botanist tends to be labelled systematist, cytologist, geneticist, ecologist, mycologist, morphologist, palæontologist, physiologist or biochemist, the underlying assumption being that he is that and little else. A further unfortunate consequence of specialization lies in the fact that common ground for discussion becomes more and more difficult to find, and in extreme cases may even lead to the view that it does not, for practical purposes, exist. Although an official cleavage between botanical morphology and physiology was avoided at the British Association meeting of 1894 in Oxford, nevertheless an adequate sense of mutual aid in the common pursuit is still lacking. The morphologist will tell you, with some over-emphasis but not without justification, that when he looks into text-books of physiology in search of information bearing on his own work, he finds that such books can tell him little that he specially wants to know; and the modern physiologist, though not habitually addicted to helping himself by making the fullest use of morphological observations, rather tends to view the professed morphologist as a relic of a former phase of botanical development and as a less adaptable and less inventive scientific man who is still plodding along in an overworked field; moreover, he, too, may complain that morphological literature fails to provide the information he specially requires. So, too, uneasy relationships exist between other and newer branches of the science. Each new aspect that arouses enthusiasm is soon attended by a profuse outpouring of specialized literature, and this, no doubt, must be accepted as being in the nature of things. But several important consequences should not be overlooked. These include: (1) vast accumulations of reading matter which are such that a worker *in any single branch* has to read constantly to keep up to date; and (2) an increased specialization of outlook, which, if left uncorrected, will make for a progressive disintegration of the science as a whole.

Now, no one would desire that specialization in the various branches of botany should cease. Such close investigation of particular phenomena is of the very nature of the scientific method. Indeed, the more facts these branches can produce, the better for biological science as a whole, provided they are made readily available to readers working in other branches. The crux of the problem, then, is this: How is the contemporary *botanist*, conscious of the need *for achieving a full and coherent account of the plant and its life*, to make the best use of the several contributory branches without wishing to deny to them the fullest freedom to pursue their own aims? For two things are certain: (1) no single human being can now hope to read in detail the literature of the several special branches; (2) no particular branch will relinquish its aims or limit its scope for the sake of the mother-subject. Thus it is not a question of re-uniting the several separate branches, or of making any one the hand-maiden of another, but of being able to synthesize or integrate the facts of these branches in the interests of the central aims of botany.

Before attempting to take the matter further, it may be advantageous to consider briefly some selected aspects of the development of botanical science.

Early Developments

It is almost certain that the early systematists, having arranged in orderly fashion the species of plants known to them, must have been conscious of having imparted coherence where none had previously existed. Here it is appropriate to refer to the works of John Ray (1628–1705), of whom Sachs has written that he "not only knew how to adopt all that was good and true in the works of his predecessors, and to criticize and complete them from his own observations, but could also joyfully acknowledge the services of others and combine their results and his own into a harmonious whole". The tribute is deserved, for though Ray's "Historia Plantarum" consists essentially of a series of descriptions of all plants then known, the work is prefaced by an account of morphology, anatomy and physiology as then understood. Later, too, Linnæus, having achieved the completion of his system, must have been conscious of having created a new and desirable unity. Along entirely different lines the German botanist, Caspar Wolff, discussed general questions such as the fundamental nature of the shoot system, and concluded, as stated in his "Teoria Generationis", 1759, that he saw nothing in the plant but leaves and stem. Later, inspired no doubt by Wolff's generalization, Goethe formulated his theory of metamorphosis in which all the various and diverse appendages of the shoot in higher plants were regarded as being the metamorphosed products of a single fundamental organ, the 'ideal' leaf. Here, indeed, the nature philosopher had conferred a unity on the objects of his study, but as Schiller pointed out to him, the abstract conceptions which he employed belonged to the realm of ideas rather than of facts.

The scholastic tradition which prevailed during the first half of the nineteenth century died hard, and botanical science made indifferent headway until Schleiden trenchantly preached a new gospel—that the highroad to new discovery lay in the study of development. It remained for his disciple Wilhelm Hofmeister to show what could thus be done. To view his work in proper perspective it is necessary to realize how very little was then known of the Cryptogams and indeed of the life-history of higher plants. The reproduction and embryology of Bryophytes and Pteridophytes constituted practically an unexplored field, while precise data relating to the development of the embryo-sac, fertilization and embryology in the higher plants were still being collected—all this rather less than a hundred years ago. The contemporary botanical world may well have been astonished when it first read the curious catalogue title of Hofmeister's paper: "Comparative Researches on the Germination, Development and Fruit Formation of the Higher Cryptogams (Mosses, Ferns, Equisetaceæ, Rhizocarpaceæ and Lycopodiaceæ) and the Seed-formation of the Conifers" (1851). It must have appeared as if the wrong things, mosses and gymnosperms, had somehow been run together for comparative treatment. But this was no fallible production, nor was the strange association of data an indication of faulty judgment, for the young German botanist was telling the world that mosses, liverworts, lycopods, equiseta, ferns, gymnosperms and phanerogams all shared a common life-cycle, characterized by the same critical events and developmental phases, and by a recurrent alternation of generations. Here, on a substantial basis of observation, was a synthesis which conveyed a sense of unity hitherto unknown. Later, in 1896, following on the discovery of chromosome behaviour, Strasburger was in a position to announce the further important generalization of the relation between the chromosome-cycle and the somatic-cycle.

Hofmeister's General Morphology

These and other examples which could be quoted afford evidence of the way in which new data and the generalizations which could be based on them not only widened the scope of botanical science but also conferred on it a new sense of coherence. These instances, however, do not convey any adequate idea of the *methodological unification* which I consider to be desirable. For such a discussion the starting-point lies in the works of Hofmeister, for he was not merely concerned with preparing descriptive accounts of changes in form during development, but he also asked himself such questions as: How does the observed form come to be? To what processes of growth can the observed structural developments be related? What internal and external factors determine specific structural organization? The substance of such investigations he described as general morphology. Not only did he consider the problems of form from the physiological aspect, but he also actually carried out physiological investigations. In short, it may be claimed for him that he achieved a view of the whole field of botanical research which, within the limits of contemporary knowledge, could not well have been bettered; with suitable modifications it is one to which we might well aspire to-day.

In introducing his new point of view to a botanical world largely given over to the speculative writing inseparable from the then prevailing idealistic morphology, Hofmeister employed little general argument. Instead of this he set about the task of replacing old conceptions by new ones based on personal investigations. A clue to his general attitude is surely given in the title of his book: "General Morphology of Growing Things" (Gewächse). As Von Goebel has said: "in this book form-relations are presented as conditions of growth. This growth is investigated". Lastly, to round off our impression of the all-round 'compleat' botanist, it may be mentioned that Hofmeister interested himself in the question of variability in plants and, while demanding further studies of the influence of external factors on the conformation of organisms, he attached himself to the Darwinian theory of descent.

The Phyletic Period

As a result of Hofmeister's admirably objective inquiries and of his critical search for relationships between physiological activity and the assumption of specific form or pattern, it might have been thought that botanical science had at length been established on a broad and sure foundation, one in which morphology and physiology were seen to be inseparable aspects of the same theme. But in what has been called the phyletic period—that which followed the publication of Darwin's theory of descent—the details of plant structure, together with such facts as could be culled from the fossil record, were regarded chiefly as providing materials for comparative studies and for the construction of phylogenetic systems. The sweeping success of Darwin's views must surely have indicated to professed phylogenists that whatever comparative investigations they carried out were bound to 'fit in' somewhere, to contribute in some measure to the wonderful edifice of evolutionary theory. The facts of development and the characteristic features of the adult were thus accepted by them as purely morphological concepts, while physiological and causal aspects, though not entirely neglected, received at best little more than passing attention. But as Prof. W. H. Lang pointed out in an important review of the situation in 1915, the problems of general, that is, causal morphology, would remain even if the phyletic history were before us in full. A bad feature of the phyletic period was the tendency of morphologists and anatomists to resort to facile pseudo-physiological arguments regarding the function and adaptive value of structures and organs. Meanwhile physiological research was going on its own way, out of sympathy, or out of touch, with the historic aspirations and interests of morphology.

Organization and Phylogeny

Each of the major phases in the development of botanical science has been characterized by a central idea. Thus in the Linnæan period the *beau ideal* was to know and classify as many species as possible and to add to that number by new collections from all the ends of the earth. In the Darwinian period and after, the problem of descent, which included the construction of phylogenetic systems, was the chief aim, use being made of the natural classifications which had been evolved during the preceding descriptive phase. Since the beginning of the present century, the mechanisms underlying physiological and hereditary processes have constituted leading themes. For contemporary workers in both botany and zoology the processes involved in progressive organization during development are providing problems of great importance and interest.

Now it is evident that organization could be studied as a subject *per se*, without reference to origins. But since all contemporary organisms have come from ancestors possessing greater or less family antiquity, and since the fossil record informs us that notable changes in structure have taken place down through the ages, it is clear that, whatever may be the findings from our studies of organization in contemporary organisms, such findings must also in some way be related or referable to the historic or evolutionary aspect. This, of course, is implicit in the once firmly held view that the ontogeny of any organism is a recapitulation of its phylogeny. It is apposite to note here that the modern study of organization differs from phyletic studies in that it is essentially dynamic in outlook.

The comprehensive viewpoint, therefore, will require that the results of contemporary investigations of plant organization be also considered in relation to the fossil record of past biological events. If an adequate understanding of the factors underlying the organization of living plants can be achieved, a fuller interpretation of the events indicated by the fossil record may become possible, though it can never be absolute. Whether the concepts issuing from contemporary studies of organization will support the criteria of comparison which have been used in the construction of phylogenies or will indicate that they lack validity is evidently a matter of the greatest importance and interest.

Entelechy and Holism

Since Driesch considered mechanistic conceptions of life to be inadequate he introduced the idea of a controlling or ordering principle—an entelechy—which was independent of physico-chemical laws though these were operative in living systems.

In his important work on "Holism and Evolution", General Smuts, too, considers that the explanation of living organisms cannot be purely mechanical and that mechanistic concepts have their place, and

justification only within the wider framework of the integrated unity of the organism. According to him, holism—defined as the "fundamental factor operative towards the creation of wholes in the universe"—is a *vera causa*, that is, a causal factor with a real existence; in the process of evolution there is a definite and fundamental tendency towards the creation of wholes, the results becoming more marked at progressively higher levels of organic development. Thus, if we take a plant or animal as a type of a whole, "we notice the fundamental holistic characters as a unity of parts which is so close and intense as to be more than the sum of its parts; which not only gives a particular conformation or structure to the parts, but so relates and determines them in their synthesis that their functions are altered; the synthesis affects and determines the parts, so that they function towards the whole; and the whole and the parts, therefore, reciprocally influence and determine each other, and appear more or less to merge their individual characters: the whole is in the parts and the parts are in the whole, and this synthesis of whole and parts is reflected in the holistic character of the functions of the parts as well as of the whole".

Whether one agrees or disagrees with the philosophical or biological implications of holism, a valuable service has been rendered to biology by the author's insistence on the essential wholeness of organisms. In the pursuit of researches into particular aspects this integrated unity should not be forgotten.

Contemporary Aspects of Integration

A survey of certain current biochemical, physiological, genetical and morphological investigations suggests that opportunities for achieving a useful integration of data derived from these several branches do in fact exist. Admittedly the number of instances which may be cited is not great; nevertheless they constitute a beginning which may in due course be notably extended.

The marked increase of interest on the part of biochemists in isolating and determining the chemical composition and physical properties of a number of physiologically active substances is likely to prove of great importance in promoting certain aspects of contemporary botanical research. In some instances these substances, which have been comprehensively described as activators, show remarkable specificity in their action on living tissues. A number of these substances have now been synthesized; an obvious development in biochemistry is to synthesize yet others. A considerable number of physiologically active organic substances of known composition, not so far known to occur in Nature, have also been produced. Physiologists, meanwhile, have been attempting to ascertain the metabolic origin and functional relationships of naturally occurring activators. This exacting branch of plant physiology is one in which substantial progress may be anticipated in due course.

The relation of these developments to the work of the morphologist may now be considered. Morphologists are concerned with the external and internal configuration of plants and regard the facts of embryology, the development of new organs at apical growing points and the attendant differentiation of tissues as integral parts of their work. Hitherto they have laboured under a serious handicap in that they have had very few working hypotheses to account for the mechanism underlying the differentiation of new organs or of new tissues. The observed developments have been regarded as characteristic manifestations of the specific hereditary substance, or in some such generalized fashion, but hypotheses relating to the operation and interaction of individual factors have been inadequate or lacking. Hence the purely descriptive nature of much morphological work and the indefinite nature of many of the conclusions based on it. But to-day a fascinating prospect of new possibilities lies before us. For example, it is known that certain substances which the biochemist can isolate or synthesize are more or less directly involved in those all-important initial differentiations of organs and tissues, or in the subsequent growth to the adult condition. Those substances, which apparently exercise a specific morphogenetic effect, have been described by Dr. J. Needham as morphogenetic hormones. Whether or not, in the complex of factors operative in the moulding of an organ, a single substance can properly be referred to as 'morphogenetic' cannot be discussed in detail here; the important fact is that specific structural developments follow on the application of certain substances to plant and animal tissues, provided the latter are in a suitable physiological condition.

Physiologists have not only been exploring the many aspects of what may be described as general cellular physiology, they have also been investigating those difficult problems which are concerned with the movement of substances throughout the plant body. It is now known, for example, that auxins, produced at the apical growing point of the shoot, that is, the region of active formation of protoplasm, become distributed throughout the plant. Important developments ensue, for example, the inhibition of buds, promotion of root development and the progressive enlargement of tissues. Now these several developments provide the materials which the morphologist is competent to investigate and of which he wishes to render an account either in terms of comparative morphology or in explanation of how the organization or configuration observed in the adult comes to be. In short, the biochemical, physiological and morphological aspects are seen to be inextricably linked, and conjoint work is essential to any reasonably adequate account of the processes involved.

Any relationship that can be established between the hereditary constitution of an organism and the possession of those metabolites which are significant in the development of its specific morphology will represent an important advance in botanical science. Here the interests of the geneticist, the physiologist, the biochemist and morphologist become confluent. So far the instances which permit of a co-ordination of data are few in number. They are, however, of great interest, not least because they indicate the possibility of such work being extended.

In an investigation of tall and dwarf strains of maize it has been ascertained (*a*) that the difference between tall and dwarf races is referable to the action of a single pair of genes, (*b*) that the initial production of auxin, an important factor in the growth-expansion of tissues, is approximately equal at the growing points in the two races, and (*c*) that the characteristic dwarfness in one race is due to the destruction of a large part of this auxin by an oxidase not present in the tall race. Here we have a genetical observation relating to an important difference in morphological configuration, which in turn can be assigned to analysable differences in metabolic activity. When precise, co-ordinated data of this kind become cumulative, as they probably will in time, the

information already gathered by morphologists and systematists may well acquire new significance and provide a new viewpoint from which to consider the central and continuous problem of evolution. Admittedly this is looking far ahead, but the goal is much to be desired.

The relation between genes and developmental processes has only recently begun to receive the attention which the subject so evidently deserves. The lack of co-ordinated development in related branches has no doubt been a contributing factor. At present very little is known about the actual physiological expression of a gene—how and where it exerts its influence: it may affect only one step in the process of development or a chain of processes; or it may be involved systemically in every aspect of development. Indeed, it is held to be improbable that any single formula will be found to unify all observations on the connexion between the influence of a gene and its results.

Biological materials in which some well-marked character is known from genetical analysis to be related to a single pair of genes seem likely to prove of great use in attempts to relate genes with developmental processes. In certain annual and biennial forms of *Hyoscyamus niger* it has been shown that if grafts of annual-flowering plants are applied to biennial stocks in their first year, flower-bud development is induced in the latter; and if the vegetative biennial scions are grafted on to annual shoots they are induced to become flowering shoots. The evidence suggests that a substance (or substances), directly or indirectly operative in flower-bud development, has passed from the tissues of the annual to those of the biennial. Now this factor, which is associated in the hereditary constitution with a single pair of genes, is productive of changes which are of profound interest to both the physiologist and the morphologist. Other instances illustrating the same community of interest relate to such characters as the shape and size of leaves, total growth, branching, difference in chlorophyll content, flower size and shape and sterility. In each, the indications are that gene-dependent diffusible substances are involved; in each the materials are such as to call for detailed physiological investigations and are of the kind on which classical systematic and morphological studies have been based.

Here, perhaps, it is appropriate to utter a word of caution. The subject-matter has been treated in such a way as to illustrate how a plurality of distinct branches of botanical science can be focused, to their mutual advantage, on the same phenomenon. But it would be a mistake to assume that the actual operational relationships involved are simple. Behind every change and development lies all the complexity inevitably associated with the multifarious operations of a metabolic system. Hence, while there is a need for simplification so that main issues and essential relationships are not obscured, the innate complexity of the processes involved should not be underestimated. Experience suggests that it is unlikely that any so-called specific morphogenetic substance is as direct in its moulding activity as the words would appear to imply. It is safer to assume that every morphological development is the result of the interaction of many factors.

To summarize briefly. The guiding lines are these: the hereditary constitution of a species, itself a small fragment of the evolutionary picture, is conceived as being subdivisible into genes; these are involved in all developmental processes; they find expression in the action of chemical substances, which in conjunction with temporal, spatial and physical factors are directly or indirectly operative in morphogenetic processes and culminate in the production of the distinctive organization of the adult.

Tissue Culture

An all-pervading consideration in biology is the physiological mechanism relating to the assumption of form, that is, to the origin of the ontogenetic growth pattern and its development to the adult status. How are we to approach this very difficult problem, and how are we to test such hypotheses as may be constructed? What, for example, are the factors leading to the institution of an apical meristem? How is it maintained in its active formative capacity? To what can we attribute the orderly development of leaf and bud primordia? What factors determine their bilateral and radial symmetry respectively and the characteristic shapes into which they are moulded during development? And the overriding 'wholeness' of the organism, what of that? These are questions on which we scarcely know how to make a beginning, for the problems are of a manifold complexity. We note that they involve the origination of cells (cytogenesis) and of organs (organogenesis)—in fact, all that is connoted by the word morphogenesis; but they also involve a great deal more.

One possible line of approach, on which a beginning if no more has been made, is by means of tissue culture. The advances made during the last thirty years in mycological and bacterial cultural methods have played an important part, and media of precise composition can be prepared on which the tissue of certain plants can be maintained in a state of growth without differentiation for an indefinite period. Here then are the means by which it may be possible to determine experimentally, on materials of known genetic constitution maintained under controlled conditions, the direct or indirect action of many factors considered to be operative in morphogenesis. Whether this hope is vain or whether it will, in fact, be realized, remains to be seen.

Conclusion

In this essay it has been quite impossible to refer to all aspects of the unification of botanical science. Studies of plant distribution, for example, which are of interest not only to the systematist, geneticist and ecologist but also to the morphologist and physiologist, have of necessity been omitted from the discussion. So, too, with taxonomy and other important branches. I have attempted to illustrate a point of view, not to cover the field.

To bring out particular points, I have referred to both conceptual and methodological aspects of unification. There are important instances where the two may be closely related. For example, the phylogenist makes use of certain morphological criteria of comparison. The validity of these criteria depends, among other things, on the accuracy of our knowledge of morphogenesis and this, on a further analysis, is seen in practice to require the conjoint work of the biochemist, physiologist and morphologist.

From the multiple-aspect-study of organization during development we not only derive some impression, however inadequate, of the organism as a whole;

we are brought face-to-face with the undeniable wholeness of the organism. A case has been made out for the view that the over-emphasis of any single aspect, while the whole is not kept in proper perspective, will almost certainly lead to the fabrication of unstable theoretical superstructures, destined to crumble because they have not been based on the fundamental reality of organic wholeness. This is a matter which concerns all botanists, though each, according to his capacity, must perform his detailed work in a particular field. But whatever that field may be, he will at one time or another be concerned with some aspect of the distinctive growth-pattern of the organism which he is investigating; this, it need scarcely be said, is of paramount interest to the morphologist at large. An interesting contrast that has been drawn between the 'substance-minded' and the 'relation-minded' man is relevant to the present discussion. "The substance-minded type of thinking," says A. H. Hersch, 1941, "is unquestionably the older, both in the individual and the race. It has all the tenacity of original sin. In morphology it has given us representative particles, preformation, the transmission of acquired characters, and such morphochemical hybrids as bristle-producing, facet-forming substances, and so on. The morphologist, when substance-minded, thinks of the developmental pattern in terms of the visible structural characteristics from stage to stage. In short, he thinks in terms of a series of pictures. But when relation-minded, the morphologist recognizes that the pattern at any moment is the expression of the events which produce it, and attempts to gain a knowledge of the durations and rates, and relative durations and relative rates of the component processes in the developmental nexus. Consequently, instead of thinking in terms of a series of pictures, the relation-minded morphologist tends to think in terms of the non-picturable. If the problem of the developmental pattern is similar to the problems of the more exact sciences, then no doubt in time a system of equations will be developed to facilitate our thinking about it".

There is the modern outlook on *one* aspect of morphology. While it is evident that certain comparative studies and all fossil studies will continue to conform to the older pattern, the new point of view suggests great possibilities for further exploration. The feasibility of pursuing these investigations to a successful conclusion will in large measure be determined by the existence of the tools to do the job. Some of these are already at hand. Here I have in mind certain major biological works recently published or re-issued, for example, D'Arcy Thompson's "Growth and Form" (2nd edn.), Needham's "Biochemistry and Morphogenesis" and Child's "Problems of Pattern and Development". Each tends to emphasize a particular aspect, but taken together they afford both the morphologist and physiologist a working knowledge of the several biochemical, physical, physiological, temporal and spatial factors which, at one or another stage of development, may be operative in moulding the distinctive form of the organism.

The publication of a major work, such as any one of those mentioned above, or of a first-class text-book, is an event of rather occasional occurrence, and depends on particular individuals who possess the experience, capacity and urge to attempt a synthesis. Now, the point of view conveyed in Hofmeister's general morphology, with appropriate modernization and thereafter subject to progressive integrated development, would appear to represent a desirable central aim in botanical science with which few would disagree. With this as a focal point, it is cogent to inquire how we are to make the best use of the data of each of the special branches, having in mind the volume of such literature, the present tendency of individual workers towards intensive research in a restricted field, the fact that this may involve disability to broader vision, and the finite mental capacity of human beings. It is undeniable that the proper comprehension of the subject as a whole is suffering from the inevitable and progressive increase in specialization. How do we propose to deal with this situation ?

I claim no originality in raising this general question and offer no solution at this stage. It is evident that underlying the numerous symposia, conferences, joint-meetings and so on, that from time to time have been convened, the same or a not dissimilar point of view has obtained ; but a more definite policy needs to be framed, continuously pursued and kept to the fore in our biological deliberations. The question of *how* this is to be done is for botanists collectively to decide. The time for doing so is at hand if a great opportunity is not to pass unheeded.

In conclusion, I wish to express my gratitude to colleagues for suggestions and much helpful criticism ; but for the opinions expressed responsibility lies wholly with myself.

SCIENCE AND INDUSTRY*

By J. G. BENNETT

Director, British Coal Utilisation Research Association

CURRENT discussions as to the part which science should play in industry are often vitiated by misconceptions as to what science and the scientific activity really are. Science is not the mere use of scientific apparatus to ascertain facts, nor the use of scientific jargon to describe them. Again, we should not use the term science to include the testing of materials and the control of technical processes as practised in modern industry. All this should be regarded as part of engineering and production technique, which only incidentally requires particular kinds of apparatus and men with a particular training. Science is not primarily a matter of technique but a *specific activity of the human mind*.

The scientific activity is as definite in its character as, for example, the artistic activity or the organizing activity, and in its highest form is as rare as either.

The basic scientific processes are observation, experiment and hypothesis formation. Hypothesis formation consists in applying to observations of natural phenomena an act of creative thought, which discovers in them a meaning which they previously did not possess. This new meaning then suggests new lines of thought and new lines of observation and experiment. The essential feature is that the new hypothesis is more than an orderly presentation of the data. It is a new view of the working of Nature, which is important as much because it is new as because it is valid.

The validity of a hypothesis is a purely relative conception, for we can never know the last word about Nature, and the whole progress of science con-

* Substance of an address at the inaugural session of the North-Eastern Section of the Institute of Fuel, Newcastle-upon-Tyne, delivered on October 18.

sists in discarding an old hypothesis in favour of a new one which is more fruitful at the particular stage which the science in question has reached. A hypothesis can be termed 'valid' in so far as it fits satisfactorily a body of observed facts and enables new facts to be predicted which can afterwards be verified by experiment and observation. In other words, the hypothesis is the actual vehicle by which scientific thought is carried forward.

The essence of the scientific method is this combination of observation and experiment with the formation of hypothesis. Science is *not* the working to some predetermined plan or schedule to find an answer to a specific question. In this lies the essential distinction between science and engineering. Any industrial process or industrial development, unless it be wild speculation, must set before itself a clearly defined aim, and the industrialist must calculate in advance the material resources which he can bring to bear and the resistance which he will have to overcome. He must have an assurance of success within what is called 'a fair commercial risk'. It is upon the engineer that the industrialist relies to provide him with the technical means for carrying the project into effect. There is an element of uncertainty in every enterprise, and the task of the engineer is to reduce that element to a minimum. However bold the project may be, he must take all possible steps to ensure that the aim specified in advance is realized within a specified time, and at a specified cost.

None of these things is possible for science. Science is continually reaching out into the unknown. It cannot calculate in advance either the results which it hopes to obtain or the time which they will take to get or their cost. Any attempt to force scientific endeavour into predetermined rigid channels destroys its very essence. The result may be useful, but it is in the highest degree improbable that it will be the creation of anything new.

The whole significance of the relations between science and industry lies in this—that it is science alone which can produce new knowledge differing not merely in precision and extent, but also in *kind*, in actual quality, from that which existed before. The industrial history of the past two hundred years shows clearly where the impact of science has been truly effective. The electrical industry owes its development to the scientific work, that is the combination of experiment and hypothesis formation, of men like Faraday, Clerk Maxwell, Hertz and Röntgen. The fine chemical industry is founded on the experiments and hypothesis formation of men like Perkin, Kekulé, Fischer and Baeyer.

It is only in the present century that the attempt has been made to bring the scientific method, properly so-called, into industry as an effective part of its operations, although it should be noted that in the highly productive period between 1750 and 1900, scientific men were themselves very much interested in the practical significance of their discoveries. The new idea that there are two kinds of scientific workers to be called respectively 'fundamental' and 'applied', one concerned with the advance of knowledge for its own sake and the other with the material results of scientific work, is an artificial one and is highly misleading. The collected scientific papers of men like Benjamin Franklin, Humphry Davy, Liebig, Pasteur and Kelvin make it clear that they regarded the pursuit of knowledge and the application of knowledge as an indivisible whole. There is no suggestion of a conflict of motive in their scientific work. It has been a retrograde step in the present century to try to distinguish between fundamental and applied science or between 'pure' and 'commercial' men of science. There is only one kind of science, and that is *the observation of natural processes, the devising and conduct of experiments and the formation of hypotheses to account for the results.*

The question is sometimes asked whether there is a valid distinction between an engineer and a scientific worker. There is certainly such a distinction, for the engineer is not concerned with hypotheses, and his attitude to observation and experiment should be essentially different from that of the scientific man. The engineer's object is to make things work. He is not interested in new knowledge for its own sake. He dislikes accidents and tries to avoid being confronted with unexpected occurrences. The man of science is above all interested in the unexpected. He does not in the least mind making mistakes, providing that they teach him something. His most fertile raw material is the experiment that goes wrong, giving a result that cannot be explained in terms of existing knowledge or theories.

A survey of the elements in industrial progress would not be complete without reference to the *inventor*. The inventor belongs to a different category and must not be confused either with the scientific man or with the engineer, though of course it is possible to have inventors who by training are scientific men and inventors who are engineers. The true inventor is not really concerned with knowing *why*, like the scientific man, or knowing *how*, like the engineer. His urge is to create; he is interested in novelty for its own sake, and he prefers to do something in a new way even if at first sight it may not offer obvious advantages over the old ways.

It is particularly important to recognize the difference in the contributions which the man of science and the inventor have to make to the progress of industry, because, on the whole, in the future, the importance of the man of science is likely to grow and that of the inventor to diminish. This is because the inventor shows to the greatest advantage where technique is primitive, and the man of science becomes more and more effective as technique is advanced.

One other misconception that needs to be removed is that 'scientific' means 'meticulously accurate'. So far from the man of science being interested in exact measurement for its own sake, he would be the first to agree that mere measurement has little value in itself. Very often rough exploratory experiments, made to find out whether things will happen in the accepted way or not, have led to far more important discoveries than a host of accurate measurements made with costly apparatus and no creative idea behind them.

To sum up, it may be stated that the true opposite of science is *empiricism*. Empiricism consists in using the results of observation and experience without attempting to understand their meaning, that is, without forming a hypothesis. A very great deal of what goes by the name of scientific research, particularly in industry, is empirical, and is therefore unlikely to lead to new knowledge and new points of view. The empirical attitude is right and indeed indispensable in the engineer, but it is wrong in the scientific worker.

With this outline of the true nature of science, attention can be turned to the question of the position of science in industry. There are essentially three

partners in the enterprise of bringing a scientific discovery into general use. The first is the scientific worker who discovers the *new* piece of knowledge. The second is the engineer who combines that new knowledge with existing knowledge and experience to make something which will *work* on whatever scale may be required. Third, there is the industrialist whose judgment, powers of organization and management provide the engineer with the conditions required for his activity and convert the enterprise into what is known as *a going concern*.

These three partners do not speak the same language, and are liable to misunderstand one another in a very dangerous way in their attempts at intercourse through the medium of garbled translation. A scientific worker is apt to view with impatience the insistence of the industrialist upon the fulfilment of certain practical conditions before he is ready to bring his resources and organizing capacity to bear on a new discovery. On the other hand, the scientific man's attempt to interpret in concrete terms of commercial production what is really a new way of thinking about the world, is apt to convey either an impression of undue optimism or else of mere vagueness and muddle. Is it then the engineer who can serve as the intermediary between the man of science and the industrialist ? This would be a mistaken solution, for engineers are essentially conservative. They rightly prefer to rely on established practice or the minimum departure from it to meet the requirements of a given problem. It is the engineer's duty so far as possible to minimize risks.

The position becomes clearer when the characteristics of a successful industrialist are examined. He must have imagination and be receptive to new ideas. Above all, he must have a capacity for seeing the possibilities inherent in a situation earlier and more clearly than his competitors. He must have judgment to weigh successfully the favourable and the adverse factors in an enterprise. In other words, he must be able to see not only the possibilities but also the difficulties in a realistic way.

Now these are just the qualities which should be applied to a new piece of scientific knowledge if it is to be used rapidly to the greatest effect. It is by combining the outlook of the man of science with that of the industrialist that the significance of a new discovery can best be gauged. It is only rarely that a scientific man has also a natural capacity for industrial insight and judgment, and is able himself to direct his work into productive channels. The conclusion is therefore reached that the man of science and industrialist are natural allies. They have more in common than either usually can appreciate, but it is difficult for them to work together not merely because they speak different languages but also because they deal with different kinds of facts. Yet any industry, where the industrialists and scientific men really come together, will make technical progress of a kind that has not been seen since the beginning of the industrial epoch. This cannot be achieved by attempts on the part of the scientific workers to popularize their ideas, or by industrialists seeking to gain a smattering of science. It can only come if scientific men take the trouble to study and understand the kinds of facts which form the subject-matter of industrial activity, and also if the industrialists try to understand what is meant by the formulation of a new scientific hypothesis. Neither of these two things is so difficult as might be thought. The mistake that is made at present when the man of science tries to explain his work to industry, is that he tends to describe experiments and observations, to give numerical examples, or attempts to forecast some practical application. He does not try to convey the *meaning* of his work, the new point of view which he has reached. This is what really matters in the scientific method, for this is the true creative work which the man of science alone can do.

THE ARGENTINE EARTHQUAKE

By ERNEST TILLOTSON

ON January 15 at about 8.51 p.m. (local time) one of the strongest earthquakes of Argentine history occurred in the Andean Province of San Juan. The epicentre of the earthquake was near the chief town in the province, San Juan, which is situated at latitude 31° 38′ S., longitude 68° 38′ W., and at this place as well as in the nearby villages there was great destruction of property and loss of life. In addition to San Juan Province, the Provinces of Cordoba, Mendoza and Larioja were affected, the latter seriously. The shock was felt throughout most of the remainder of the Argentine, and also in Chile and in Uruguay. It was recorded on seismographs at many observatories throughout the world, including some in Great Britain. At La Plata it was recorded very strongly, and at Buenos Aires the recording suddenly ceased nearly as soon as it began owing to the violent, large amplitude earth waves being too great for the pendulum, which became unhinged. The recording needles of the instrument were also broken.

In San Juan, a city with a population of about eighty thousand people, about two thirds of the buildings immediately collapsed, and others were damaged in varying degrees. Among the large buildings thus affected were the cathedral, numerous churches, Government House, municipal buildings, the railway station and the post office. Fissures and fault cracks appeared in the streets. Electric cables were broken, gas mains were shattered, water pipes were burst open, and telephone communication within the city and to the outside world ceased. Roads, especially the narrow ones, were blocked with the debris of crashed buildings, and rail traffic was stopped by fissures, fallen debris and twisted rails. In the city fires raged, having been started by the shaking of hot coals from the fireplaces, by gas escapes and by electric short circuits. Even if the fire brigades could have got to them, there would have been no water supply, and so they burned themselves out unchecked. Unfortunately, at the time many people were in cafés, cinemas and restaurants and were trapped in the buildings and narrow streets. The death roll is undoubtedly high, and three thousand bodies have so far been found and burned. More than another three thousand are injured, and when the casualties in the surrounding villages are counted the death-roll may be as high as five thousand. Fortunately rail communication with Mendoza was quickly resumed, and radio communication with the city was found possible. Drinking water was sent from Mendoza, one hundred miles away. Many of the people are now living in tents and relief work is in progress. San Juan is to be completely evacuated and cleared, and when it is rebuilt it will be spacious and the buildings will be of earthquake-proof design. The evacuation would

appear inevitable as aftershocks, including a very violent one some thirty-six hours after the first earthquake, caused buildings previously damaged to collapse, and damaged most of the remaining ones.

In Buenos Aires in the eastern Argentine the original earthquake was sufficiently pronounced to sway street lamps. The shock was also distinctly noticeable in the upper stories of sky-scrapers. The last strong earthquake which affected San Juan and destroyed some property occurred on October 27, 1894. On that occasion La Rioja was also affected, though the shock was not so severe as the present one. The Argentine is definitely a country where earthquakes are liable to occur from time to time, though it is not so greatly affected as its neighbour Chile. It is that part of the Argentine nearest to the Andes Mountain Chain which is most affected and not so much the eastern plains. The Andes form part of the great circum-Pacific belt of instability, round which more than half of the world's great earthquakes occur. Although earthquakes of destructive violence have happened from time to time in the twentieth century in the Argentine, they have usually been centred away from densely populated areas and towns. In the nineteenth century there were several outstandingly destructive shocks. On April 9, 1849, San Luis was destroyed. On March 20, 1861, Mendoza experienced widespread destruction, and on October 22, 1871, Jujuy and Oran suffered this same fate, to name a few outstanding examples.

NEWS and VIEWS

Sir Richard Gregory, Bart., F.R.S.

JANUARY 29 marks the eightieth birthday of Sir Richard Gregory, president of the British Association and formerly editor of NATURE. To many who have known him, this may come as a surprise, for his energy and alertness seem unabated with the passage of years. Upon his retirement from the editorship of NATURE at the end of 1938, Sir Richard gave scientific men a message which in some ways may be regarded as his own philosophy of life (see NATURE, January 7, 1939, p. 1). In it he shows his profound belief in the significance for the future of mankind of scientific progress and its application to human affairs. His labours to this end were fittingly acknowledged by his election in 1933 to the Royal Society, under the special rule which permits election to the fellowship for "conspicuous service to the cause of science".

But Sir Richard did not retire from public life when he relinquished his editorial post at the age of seventy-five; his new leisure was quickly occupied with other interests. During the forty-five years of his association with NATURE, he had always taken a prominent part in the work of the British Association, and in particular of Section L (Education), which he served in many capacities, becoming president in 1922. Finally, at the ill-fated meeting at Dundee in 1939, which had to be abandoned through the outbreak of war, he was elected president of the British Association for 1940 (see NATURE, September 9, 1939, p. 472), and has, of course, remained in that office since. Due largely to his initiative, the Association, through the new Division for the Social and International Relations of Science, has, in spite of war-time conditions, managed to hold meetings of limited scope in Reading, Manchester, and London. Sir Richard Gregory has made many friends on his visits to South Africa (with the British Association), to India and to the United States, who will feel a particular interest as they join with other scientific men in congratulating him upon his past achievements and sending him their good wishes for the future.

Colonial Products Research Council: Report

THE first interim report of the Colonial Products Research Council states that the procedure adopted, which was modelled on and adapted from that of the Department of Scientific and Industrial Research, the Medical Research Council and the Agricultural Research Council, is to make the fullest possible use of existing research facilities in universities and other institutions, delegating to them the investigation of specific problems on terms mutually arranged. Researches already planned or initiated in this way include investigations on sucrose and sucrose derivatives under Prof. W. N. Haworth at the University of Birmingham; on eugenol and *iso*eugenol under Prof. G. R. Clemo at the University of Durham; on lime oil, lime juice and citrus under Prof. I. M. Heilbron at the Imperial College of Science and Technology, London; on fixed oils and fats under Prof. T. P. Hilditch at the University of Liverpool and Dr. Ida Smedley-MacLean at the Lister Institute; on caffeine and theobromine under Prof. A. R. Todd at the University of Manchester; on petroleum products under Sir Robert Robinson at the Dyson Perrins Laboratory, Oxford; and on the production of ergosterol at the Chemical Research Laboratory under Dr. A. C. Thaysen. The Council is also engaged in reviewing the field of research into vegetable drugs. The Director of Research has been accommodated at the Imperial Institute by the courtesy of Sir Harry Lindsay. While the function of the Council is to organize and sponsor fundamental and applied researches on Colonial commodities, with the primary object of finding new uses for them, the Institute will continue its chemical investigations of Empire raw materials in accordance with its statutory obligations and will furnish information to producers and potential customers on sources of supply, markets, the preparation of commodities for commercial and industrial use, and the economic possibilities for any given commodity, etc.

The Education Question: a Biological Approach

THE inaugural address at the University of Leeds School of Medicine delivered last autumn was by Sir John Graham Kerr, who announced as his subject "Medicine and Education". To what extent the substance of the address answered the expectations of the audience is perhaps doubtful, but there is no doubt whatever that it answered to one of the needs of the hour. Sir John pointed out that, among primitive peoples, a boy becomes a highly trained observer by eye and ear, he acquires the ability to interpret rapidly and correctly what he observes and he learns to keep his wits constantly alert. As boyhood passes into adolescence, he accompanies his elders on their expeditions, and his education continues as before. That the education of to-day has departed so widely from its original

type is, added Sir John, due, paradoxically, to one of the most beneficent events in the history of our civilization—the invention of the printed book, which brought with it the possibility of mass education. An inevitable result of the domination of education by the printed book was the reduction to a position of relative unimportance of that training in observation, judgment and mental alertness which formed so important a part of education in the earlier phases of communal evolution. In the child's pre-school life, we still have that kind of training, as also in later adult life of vocational employment. But in the intervening period of school life, the boy becomes in the main an absorber of information obtained from the printed page. The remedy lies not in further overloading the school curriculum, but in correcting some of the existing wastage. As to girls' education, Sir John, believing it to be a question for the women of the country, declined to commit himself, except to say that the education of a girl should be permeated with the realization that the highest ideal of her sex is that of home and family.

Higher Education in the Caribbean

THE Commission on Higher Education in the Colonies (see NATURE, August 21, 1943, p. 211) has appointed a committee of its members, and co-opted representatives from the West Indies, with the following terms of reference: "To review existing facilities for higher education in the British colonies in the Caribbean and to make recommendations regarding future university development for these colonies." The committee is constituted as follows: Sir James Irvine (chairman), vice-chancellor of the University of St. Andrews; Prof. A. M. Carr-Saunders, director of the London School of Economics and Political Science; Miss Margery Perham, reader in Colonial administration at the University of Oxford; Dr. R. E. Priestley, vice-chancellor of the University of Birmingham; Mr. P. Sherlock, secretary of the Institute of Jamaica; and Mr. H. Springer, member of the House of Assembly, Barbados; with Mr. T. R. Rowell, assistant educational adviser at the Colonial Office (secretary). The committee will spend some three months visiting Jamaica, Trinidad, Barbados and British Guiana. Mr. W. D. Inniss, lately assistant master at Queen's Royal College, Trinidad, will serve on the committee while it is in Trinidad, and Mr. J. A. Luckhoo, member of the Executive and Legislative Councils, British Guiana, while it is in that colony.

An Idealist View of Special Publications

IN a paper "Streamlining Production and Distribution of Current Periodical Articles" (*Special Libraries*, 34, No. 6, July–August 1943), Zeliaette Troy, librarian of the Boyce Thompson Institute for Plant Research, after directing attention to the difficulties which the present system of publication offers to individuals as well as to libraries, and to the drawbacks of inter-library loans, film copies and photostat copies, suggests a scheme for minimizing the mechanics of publication and distribution. Under this scheme, an author would complete his article and send it to the usual editors, by whom, on approval, it would be sent to a central printing office. There the manuscript and abstract would be stamped with the date of receipt, and the authorizing organization indicated. When the article and abstract are in printable form, they would receive a common chronological number, followed by a classification number, after which the cost accountant would put a price on the article and on the abstract in accordance with the number of copies to be printed, and both items would go to the printing establishment.

The printers would thus supply a stream of scientific articles uniform in size, with the author, title, name of the organization sponsoring and paying for it, the date of receipt, the master number and the classification number or numbers. They would also supply a periodical index and abstract journal issued both in its entirety and by subject sections. Members of a subscribing organization would receive one copy each of the publications authorized by it. Individuals or libraries subscribing for all articles in certain classifications would be similarly supplied. The index-abstract journal would have an annual paid subscription charge both for the complete issue and its sections.

The advantages of the proposed system to the individual, in the absence of delays in publication and in being sure of seeing all articles on the subjects falling within the classifications for which he subscribes, in the relief from the burden of proof-reading and the distribution of proofs are clearly indicated, and the failure of the individual to distinguish between his working tools and his 'browsing' literature is emphasized: the latter might well be left to his library, and only those articles of fundamental and immediate importance to him taken into his private collection. Libraries would have the further advantages of being relieved of inter-library loans and expensive and inadequate reproductions. Binding problems would be simplified and some binding could be eliminated.

Geological Society: Medal Awards

THE Council of the Geological Society announces the following awards: Wollaston Medal to Prof. V. M. Goldschmidt, professor of geology, Frederiks University and Museum, Oslo, for his outstanding contributions to Norwegian petrology, and his fundamental researches into the structure of crystals and the distribution of the chemical elements in the earth; Murchison Medal to Prof. V. C. Illing, of the Imperial College of Science and Technology, for his talented contribution to oil geology and Palæozoic stratigraphy; Lyell Medal to Dr. N. R. Junner, of the Geological Survey of the Gold Coast and Sierra Leone, for his contributions to the stratigraphy of the Pre-Cambrian and his discoveries of valuable minerals associated therewith; Wollaston Fund to Mr. A. G. Brighton, curator of the Sedgwick Museum, Cambridge, for his services to palæontology and his researches on the echinoderms; Murchison Fund to Mr. G. M. Stockley, of the Geological Survey, Tanganyika Territory, for his work on the stratigraphy, palæontology and mineral resources of East Africa; one moiety of the Lyell Fund to Dr. S. Buchan of the Geological Survey of Great Britain, for his work on underground water resources of the London area; another moiety of the Lyell Fund to Mr. E. W. J. Moore, of Haslingden, for his researches on carboniferous goniatites.

Presidency of the American Chemical Society

PROF. C. S. MARVEL, professor of organic chemistry in the University of Illinois, has been elected president of the American Chemical Society for 1945. Prof. Marvel will take office as president-elect on January 1,

1944, when Dr. Thomas Midgley, jun., vice-president of Ethyl Corporation, and known for his discovery of tetraethyl lead, becomes president, succeeding Dr. Per K. Frolich, director of the Chemical Division, Esso Laboratories, Standard Oil Development Company, Elizabeth, New Jersey. Dr. Marvel was recently awarded the 1944 William H. Nichols Medal of the New York Section of the American Chemical Society. He has made outstanding contributions to research on the structure of vinyl polymers, used as synthetic plastics, particularly in the production of transparent aircraft parts, as rubber substitutes, and as thickening and blending agents in the chemical manufacturing industry. He has also made important researches on the structure of polymers of sulphur dioxide and olefines, and has developed practical methods for preparing amino-acids.

Wind and Bird-Migration

DR. NORMAN H. JOY (*Field*, Dec. 11, 1943) has published a short account of observations on bird-migration maintained almost continuously for four years at Dungeness, on the coast of Kent. This is useful work, of a kind not often undertaken so intensively. He has, in particular, noted the conditions of departure across the English Channel in autumn. As only selected observations are given, it is difficult to make a critical assessment of the conclusion that birds of certain species, for example, swallows, leave only when there is a contrary wind. The frequency with which birds are seen migrating against the wind has often been remarked. To some extent the impression may be exaggerated—birds flying across the wind (as Dr. Joy points out) have to head partially into it to correct their drift; and birds flying against the wind, at reduced speed in relation to the ground, remain longer under notice. In any event, it is open to question whether the relation between wind and a migratory movement is one of cause and effect, or whether they have a common origin in the general meteorological situation. Dr. Joy's suggestion that birds find a head wind advantageous because it gives them more lift is untenable: once it is airborne, a bird can derive no lift from the body of air within which it moves (assuming, for simplicity, that the current is horizontal and of uniform strength), except as a result of its own air speed.

Poisonous Reptiles of the World

THE Smithsonian Institution "War Background Studies", No. 10 is on the poisonous reptiles of the world, by Doris M. Cochran (Smithsonian Inst., 1943). It contains brief accounts of all the principal poisonous reptiles arranged in geographical groups, namely, the United States, Latin America, Europe and northern Asia, India and Malaya, Africa and Australia, New Guinea and the South Pacific Islands. The brochure is illustrated with seventeen plates, the first of which is coloured and most of which contain two species. There is also a small selected bibliography and an appendix dealing with first aid treatment, the preparation of antivenin and directions to collectors. From it medical officers should be able to identify any of the ordinary poisonous reptiles with which they are likely to be concerned even without previous knowledge of the group. It is obvious also that it will be useful to others than to those for whom it is particularly written.

Fishes from Philippine Seas

HENRY W. FOWLER has described many new fishes in his recent paper "Contributions to the Biology of the Philippine Archipelago and Adjacent Regions. Descriptions and Figures of New Fishes obtained in the Philippine Seas and Adjacent Waters by the United States Bureau of Fisheries Steamer *Albatross*" (U.S. National Museum, Bull. 100, **14**, part 2. Smithsonian Institution, 1943). These belong to several families and form an appendix to the detailed reports on these groups of *Albatross* fishes. There are ten new genera, one new sub-genus, one new sub-family and twenty-two new species in this paper. Many of these fishes are of striking form, notably *Calliurichthys lineathorax* n.sp., with its enormously long caudal fin as long as all the rest of the fish. All the illustrations are excellent.

The Night Sky in February

FULL moon occurs on Feb. 9d. 05h. 29m. U.T., and new moon on Feb. 24d. 01h. 59m. The following conjunctions with the moon take place: Feb. 3d. 06h., Mars 7° N.; Feb. 4d. 07h., Saturn 3° N.; Feb. 9d. 11h., Jupiter 0·4° S.; Feb. 21d. 20h., Venus 1° S.; Feb. 22d. 20h., Mercury 1° S. The following occultations of stars brighter than magnitude 6 take place: Feb. 4d. 22h. 58·6m., 57 Ori. (*D*); Feb. 5d. 03h. 23·6m., 64 Ori. (*D*); Feb. 7d. 18h. 36·7m., d^1 Canc. (*D*); Feb. 7d. 23h. 43·0m., θ Canc. (*D*); Feb. 17d. 06h. 01·1m., η Lib. (*R*). The times refer to Greenwich and *D* and *R* refer to disappearance and reappearance respectively. Mercury rises at 6h. 28m. at the beginning of the month and at 6h. 44m. at the end of the month, and is too close to the sun to be favourably seen. Venus rises a little before 6h. throughout the month and is a conspicuous object in the morning hours. Mars can be seen through a good portion of the night, setting at 3h. 57m., 3h. 26m., and 2h. 56m. at the beginning, middle and end of the month. Jupiter is in opposition on Feb. 11 and can be seen throughout the night, setting at 8h. 21m. and 6h. 20m. at the beginning and end of the month. Saturn is a little east of Mars and sets about 15 minutes later than Mars in the middle of the month. At the beginning and end of the month Saturn sets at 4h. 35m. and 2h. 42m. The planet is stationary on Feb. 20.

Announcements

WE regret to announce that Dr. W. W. C. Topley, F.R.S., secretary since 1941 of the Agricultural Research Council, and formerly professor of the division of bacteriology and immunology in the University of London, died on January 21, aged fifty-seven.

THE Council of the Royal Aeronautical Society has elected Group Captain F. Whittle a fellow of the Society; such an election is a special distinction in recognition of work of great importance in aeronautics.

MR. ATTLEE, Lord President of the Council, has announced that the Government has appointed the following committee to consider and make recommendations as to the development of television after the War: Lord Hankey (chairman); Sir Noel Ashbridge and Mr. Robert Foot, B.B.C.; Sir Raymond Birchall and Sir Stanley Angwin, General Post Office; Mr. Harvey, Treasury; Sir Edward Appleton, Department of Scientific and Industrial Research; and Prof. J. D. Cockcroft, Ministry of Supply.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Fluorescence as an Aid to Physiology

THE great value of fluorescence as a guide to physiological activities was first brought home to me in 1925, when I observed that cod-liver oil which had been exposed to sunlight had lost its fluorescence. Following up this simple observation, I found that the loss of fluorescence was accompanied by the loss of vitamin A[1]. The value of fluorescence in the search for pure chemical carcinogens was proved by Kennaway and Hieger[2], who used the fluorescence of carcinogenic fractions of tar as a guide, which eventually led to the identification of benzpyrene, though the first pure chemical carcinogen identified by them was 1 : 2 : 5 : 6-dibenzanthracene, which they suspected of being carcinogenic on the strength of its fluorescence and absorption spectra.

During the past eighteen years, I have repeatedly made use of fluorescence in a variety of experiments the primary purpose of which was related to cancer, but in the course of such work I have repeatedly noted observations of physiological interest, some of which have been described in journals devoted to cancer research and thus not likely to excite interest among those concerned mainly in experimental physiology. It seems possible that some of these observations might be of interest apart from their bearing on cancer, and, in this hope, I should like to place them on record.

(1) As a method of demonstrating the great speed at which substances can travel in the blood stream, I know of nothing so striking as a fluoroscopic examination of blood collected drop by drop from one ear of a rabbit during the period of injection into a vein of the opposite ear of a colloidal suspension of benzpyrene or anthracene, every particle of which is brilliantly fluorescent. In this way, it is possible to demonstrate that the maximum speed of circulation is much greater than one would estimate from experiments in which dyestuffs are injected, as the sensitivity of the fluorescent method is enormously greater than that of colorimetric methods. Many fluorescent substances can readily be detected in dilutions of more than one in a million, and, in the case of colloidal suspensions, in far higher dilution.

(2) The rapidity with which such fluorescent particles disappear from the circulating blood (within fifteen minutes) led to the observation of the mechanism of elimination of hydrocarbons, which has been published in detail elsewhere[3], and illustrated, incidentally, a beautiful method of visualizing part of the mechanism of excretion by the liver. This is so striking and so easily demonstrated that one would think it must be of interest to those who teach students about the physiology of the liver. The change from the colloidal state to true solution, in the liver, and the metabolism to the hydroxy-compound can also be visualized clearly in the case of benzpyrene, owing to the different coloured fluorescence seen in different stages of the process. The subsequent excretion in the bile demonstrates the rate of secretion and excretion of the fluid, and can also be used to show peristaltic waves passing along the intestine and the rate of movement of its fluid contents. Moreover, it can be shown that in the case of chicks *in ovo* the gall-bladder does not contract; so the bile with which it is filled remains non-fluorescent after intravenous injection of fluorescent substances, while the hepatic ducts and intestine stand out in striking contrast, by reason of their content of fluorescent bile. In the newly hatched chick, however, as soon as it begins to peck food or even eggshell, the gall-bladder contracts and rapidly fills with fluorescent bile, thus demonstrating that contraction of the gall-bladder is related to the presence of food in the alimentary canal. Some of these observations have been published[4].

(3) Recently, I have observed a striking and peculiar appearance in the cæcum of a mouse following a fluorescent meal. Fluorescence of the organ in this animal showed a sharp line of demarcation dividing it axially into fluorescent and non-fluorescent parts, the fluorescence being limited to the concave half of the organ. Although I have repeated this experiment a few times, I have not again killed an animal at the precise time at which this phenomenon could be observed, suggesting that it is only of very temporary duration, but possibly throwing light on the method of action of this organ.

(4) As a last example, I should like to cite what, for want of a better name, I have termed 'loop-way' excretion by the liver of substances that are finally excreted by the kidney. This can be beautifully illustrated by injecting mice intravenously with 1 per cent fluorescein solution, and killing them at intervals up to one hour or more after injection. It will be seen in such experiments that the liver and kidney simultaneously excrete the dye, so that it is voided in the urine at the same time that it is being excreted into the bile and so into the intestine. As this substance is readily diffusible, it is rapidly reabsorbed from the intestine, while renal excretion continues to lower the blood level of the substance. In this way, finally, it is all excreted in the urine. Thus, if one limited the experiment to observations on the amount injected and the amount excreted in the urine, no evidence would be obtained of the important loop-way action of the liver in lowering the blood level. Many other substances, including indigo carmine, used in renal efficiency tests, can be shown to follow the same route in animals with experimental biliary fistulæ.

Some of these observations have appeared, as stated above, in journals not devoted to physiological experiments; others have not been published at all. I am not primarily concerned with physiological experiments, and so cannot devote time to pursuing them as far as I could wish. It is possible that such effects are already well known to some physiologists; but I believe that this is not generally true and that it is not widely appreciated how very easy the detection of fluorescent substances in the animal body can be. The only apparatus required is a source of ultra-violet rays, screened by Wood's glass, and a dark room in which observations can be made by an observer whose eyes are adapted to the dark.

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Dec. 9.

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Function of Carbonic Anhydrase in Blood

CARBONIC anhydrase, which catalyses the reversible reaction

$$CO_2 + H_2O \rightleftarrows H_2CO_3,$$

is an intracellular enzyme found in high concentration within red blood corpuscles[1]. The activity of this enzyme and the kinetics of the reactions it catalyses have been studied mainly either with laked corpuscles or with hæmoglobin-free enzyme preparations. Suspensions of intact corpuscles tested by the usual colorimetric or manometric methods were found to be almost completely inactive. The activity of carbonic anhydrase within the red blood corpuscles, as well as its relationship to the chloride shift, were demonstrated spectroscopically by Keilin and Mann[2]. They used for this purpose red cells in which hæmoglobin had been oxidized to methæmoglobin; the latter acting as an indicator changing its colour and absorption spectrum with the pH of the surrounding medium. The activity of carbonic anhydrase was determined by them from the velocity of these changes in presence and in absence of sulphanilamide, which they found to be a highly specific inhibitor of this enzyme[3].

The present communication summarizes the results of experiments which demonstrate that the uptake and liberation of carbon dioxide can be catalysed by the carbonic anhydrase present within normal intact red blood corpuscles.

The experiments on the velocity of carbon dioxide uptake were carried out as follows: 20 ml. of horse blood or of a suspension of corpuscles are put in a 350 ml. flask, carefully evacuated and equilibrated with pure nitrogen or pure oxygen. 10 ml. of this blood is introduced through one of the apertures into a 250 ml. Woolf bottle filled with a gas mixture containing 5 per cent carbon dioxide in nitrogen or in oxygen. The bottle is fixed to a stationary shaking apparatus and its second aperture is connected by means of a three-way tap to the manometer. When the temperature is equilibrated, the taps are closed and the bottle is violently shaken and the manometer is read every 15 seconds. The same procedure was adopted for the study of the liberation of carbon dioxide, the only difference being that the blood was first equilibrated with the gas mixture containing 5 per cent carbon dioxide and then transferred to the Woolf bottle containing pure nitrogen or pure oxygen.

The results of these experiments, which are shown in Fig. 1 (*A* and *B*), can be summarized as follows: (1) The velocities of either the uptake or the liberation of carbon dioxide are markedly decreased by the addition of a small amount of sulphanilamide, but are not affected by sulphapyridine, which confirms the previous observations by Mann and Keilin[3] as to the effects of these drugs on carbonic anhydrase. (2) Although sulphanilamide decreases the velocities of these reactions, it has no effect on the equilibrium point, which is ultimately reached and which depends only on the total buffering capacity of the sample tested. In fact, by extrapolation Curve 4 will meet Curve 1. (3) Sulphanilamide will thus differentiate the buffering capacity of corpuscles from their catalytic activity, both of which influence the velocities of carbon dioxide uptake and liberation. (4) The slowness of carbon dioxide uptake or liberation by serum alone after the first minute of the reaction is partly due to its low buffering capacity. (5) In all these experiments the velocity of carbon dioxide liberation was lower than that of uptake. This may be due to the state of oxygenation of hæmoglobin. However, further experiments are

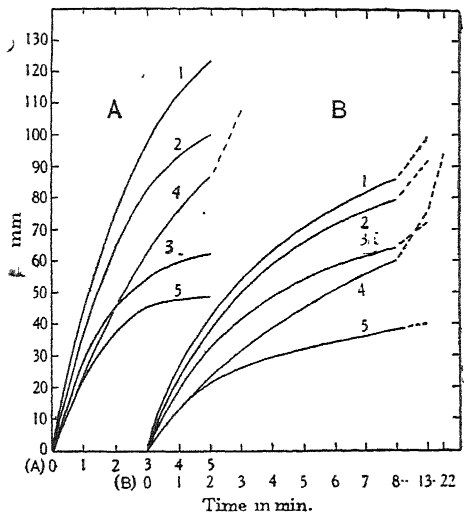

FIG. 1.

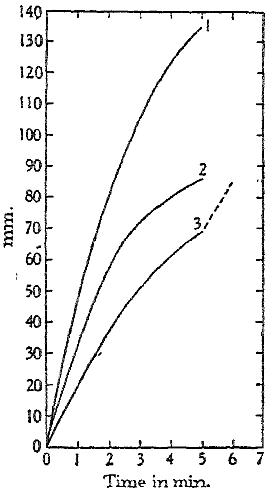

FIG. 2.

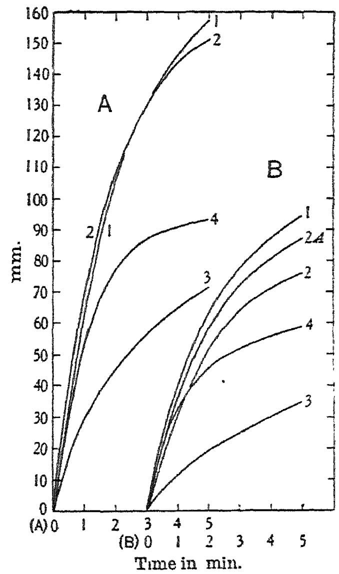

FIG. 3.

FIG. 1. UPTAKE (*A*) AND LIBERATION (*B*) OF CARBON DIOXIDE BY RED BLOOD CORPUSCLES SUSPENDED IN A MIXTURE OF SERUM AND SALINE 1 : 1.
(1) 50 per cent blood corpuscles; (2) 30 per cent blood corpuscles; (3) 10 per cent blood corpuscles, (4) 50 per cent blood corpuscles + 0·15 per cent sulphanilamide; (5) the serum-saline mixture without blood corpuscles.

FIG. 2. UPTAKE OF CARBON DIOXIDE BY RED BLOOD CORPUSCLES.
Washed 3 times with 0·2 *M* phosphate, pH 7·3, and suspended in (1) mixture of 6 per cent glucose and 0·9 per cent sodium chloride; (2) 6 per cent glucose; (3) 6 per cent glucose + 0·15 per cent sulphanilamide.

FIG. 3. UPTAKE (*A*) AND LIBERATION (*B*) OF CARBON DIOXIDE BY RED BLOOD CORPUSCLES SUSPENDED IN A MIXTURE OF SERUM AND SALINE, 1 : 1.
(1) 50 per cent blood corpuscles; (2) 50 per cent blood corpuscles + 0·4 ml. conc. sol. of carbonic anhydrase; (2*A*) 50 per cent blood corpuscles + 0·1 ml. conc. sol. of carbonic anhydrase; (3) the serum-saline mixture alone; (4) the serum-saline mixture + 0·4 ml. concentrated sol. of carbonic anhydrase.

required for an adequate explanation of this phenomenon.

The relationship between the activity of carbonic anhydrase and the chloride shift was postulated by Roughton[4] and demonstrated by Booth[5] and by Keilin and Mann[2]. This was confirmed in the course of the present investigation. As shown in Fig. 2, the activity of the red blood corpuscles washed in isotonic phosphate solution and suspended in 6 per cent glucose solution is much lower than the activity of these corpuscles suspended in glucose solution which was diluted with an equal volume of 0·9 per cent sodium chloride. The activity of corpuscles in absence of sodium chloride was not, however, completely abolished, since it is still higher than that of the same suspension poisoned with sulphanilamide.

The fact that on hæmolysis of the red blood corpuscles, which may occur under certain pathological conditions, carbonic anhydrase is liberated into the plasma suggested the study of the influence of the extra-corpuscular enzyme on the catalytic activity of corpuscles. For this purpose the activity of the suspension of corpuscles in diluted serum or 0·9 per cent sodium chloride was tested with and without the addition of free carbonic anhydrase. The results of these experiments, summarized in Fig. 3, show that the catalytic activity of corpuscles in the liberation of carbon dioxide is distinctly inhibited by the presence of an extra-corpuscular enzyme, and that the degree of this inhibition is proportional to the concentration of enzyme. On the other hand, the carbon dioxide uptake does not seem to be affected by the presence of an extra-corpuscular carbonic anhydrase.

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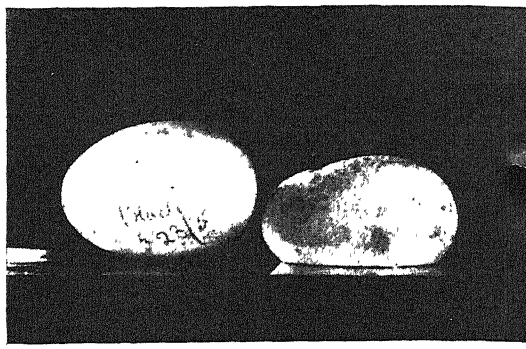
Carbonic Anhydrase, Sulphonamides and Shell Formation in the Domestic Fowl

Meldrum and Roughton[1] were the first to advance the hypothesis that carbonic anhydrase might play a part in egg-shell formation by influencing the rate of formation of the anion of calcium carbonate by catalysis of the reaction $CO_2 + H_2O = H_2CO_3$. Following up this suggestion, Common[2] examined the tissues of the hen's oviduct for their carbonic anhydrase activity, and concluded "that the carbonic anhydrase activity of the uterine epithelium is higher than that of the remaining oviducal tissues, and that this activity may play a part in shell secretion". On the other hand, it has been demonstrated by Keilin and Mann[3] that compounds of the $R SO_2NH_2$ type (where R is a benzene, naphthalene or pyridine ring) specifically inhibit carbonic anhydrase in very small concentrations. This property, however, is absent in all such compounds in which the sulphonamide group is substituted, as it is, for example, in sulphapyridine or sulphathiazole.

With these findings in mind, we administered representative compounds of the unsubstituted and substituted $R SO_2NH_2$ type to laying hens, in order to investigate their effect on shell secretion. It was



first necessary to ascertain an appropriate dose, which would not produce any of the undesirable symptoms of sulphanilamide poisoning such as cyanosis, dyspnœa and muscular weakness, and would nevertheless inhibit carbonic anhydrase to a sufficient extent. Birds were given sulphanilamide in gelatine capsules *per os* and the concentration of the drug in the blood was estimated. The results agreed well with those of Litchfield, jun.[4], with regard to the maximum concentration obtainable with different doses, although blood-levels varied according to the rate of absorption by different birds (Table 1).

TABLE 1. BLOOD CONCENTRATION OF (FREE) SULPHANILAMIDE IN MGM./CENT. (DOSE, 0·1 GM./KGM.)

Birds	6 hr.	24 hr.
1	2·46	4·92
2	5·48	2·90

Finally, a single dose varying from 0·1 to 0·2 gm./kgm. was adopted and administered to nine laying hens (five Rhode Island Reds and four Light Sussex). In every case there was a marked effect on the shells laid, varying from an entire absence of shell to a completely formed but very thin and characteristically pitted shell. The same birds were afterwards given sulphapyridine and the shells obtained were normal throughout. In the photograph are shown two eggs, laid by the same hen, the shell-less one being laid when the hen was receiving sulphanilamide and the normal one when it was being given sulphapyridine.

It should be emphasized that throughout these experiments the birds showed no ill-effects whatsoever, and their appetite and laying capacity seemed unimpaired.

The concentrations of free and acetylated sulphanilamide and sulphapyridine in the homogenized egg-contents were determined, wherever possible, using Mawson's[5] modification of Werner's method. Some of the results are given in Table 2.

TABLE 2. CONCENTRATION OF SULPHONAMIDES IN THE EGG-CONTENTS IN MGM./CENT. (i = free; ii = acetyl)

a. Sulphanilamide

Birds	Days after dosing 1		2	
	i	ii	i	ii
3	1·64	7·75	0·36	2·42
7	3·54	10·01	0·68	1·76

b. Sulphapyridine

Birds	Days after dosing 1		2		3		4	
	i	ii	i	ii	i	ii	i	ii
5	0·70	1·06	0·56	1·63	0·38	0·65	—	—
6	0·52	0·56	—	—	0·86	0·05	0·23	0·11

Birds	Days after dosing 5		6		8	
	i	ii	i	ii	i	ii
5	0·35	1·19	0·50	—	—	—
6	0·46	1·30	—	—	0·19	—

The following points emerge from these experiments: (1) Acetylation in the hen is pronounced,

which again confirms the findings of Litchfield. This does not, however, interfere with the purpose of the experiments, since acetylation takes place at the para-amino group and the total amount of active sulphonamide group remains undiminished.

(2) The inhibitory action of sulphanilamide on carbonic anhydrase is completely reversible, bearing out the observations of Keilin and Mann in their *in vitro* experiments. The effect on shell formation disappeared completely after all the sulphanilamide had been eliminated. Moreover, a graded effect on the shells was observed after the usual single dose. Thus, the shells laid on successive days showed a diminishing effect which was correlated with the decreasing concentration of sulphanilamide in the egg-contents (Table 2*a*). It was also noted that the effect on the shells laid by any one bird depended upon the time which elapsed between dosing and laying. The most marked effect was observed after a period such as could be presumed to permit of the attainment of a maximum sulphanilamide concentration in the blood during the course of shell secretion.

(3) It will be seen that the concentration of sulphapyridine in the egg-contents was always lower than that of sulphanilamide. This is a phenomenon which has been noted and discussed previously by other investigators[4,6]. In addition, sulphapyridine, unlike sulphanilamide, was excreted with great difficulty by the fowls, and was found in the eggs for so long as eight days after a single dose of 0·2 gm./kgm. These findings are probably explained by the very poor glomerular function of the fowl[4,6].

(4) It was observed that while normal egg-shells (as well as the shells from hens dosed with sulphapyridine) showed a uniform reddish-purple fluorescence in ultra-violet light, those laid by hens receiving sulphanilamide presented an uneven, blotchy fluorescence. This might be due to direct interference with porphyrin metabolism or to an irregular deposition of calcium porphyrinate, in line with the faulty shell secretion as a whole.

It therefore appears that carbonic anhydrase is essential for shell formation in the domestic fowl, for which purpose the anion of the calcium carbonate seems to be of equal importance with the cation. Thus, interference with normal anion production by way of the mechanism suggested may provide the explanation for the well-known phenomenon of pathological production of soft-shelled eggs by hens adequately supplied with calcium in a suitable form.

We are indebted to Messrs. May and Baker, Ltd., for the generous gift of sulphonamides.

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Claviformin from *Aspergillus giganteus* Wehm.

THE production of a penicillin-like substance from *Aspergillus giganteus* has been described[1]. Wilkins and Harris[2] noted that this mould produced a different antibiotic when grown in a different medium, namely, dextrose 4 per cent, $NaNO_3$ 0·1 per cent, KH_2PO_4 0·1 per cent. When tap water was substituted for distilled water, production of the antibiotic was slower but the final yield greater. The mould was harvested after 4–8 weeks incubation. The active material was concentrated by adsorption on charcoal, extraction with amyl acetate and finally extraction with ethyl acetate. On concentrating and cooling this extract, crystals of active material were obtained the properties and appearance of which at once suggested that the antibiotic was identical with claviformin[3]. It had a melting point of 109° C., and no depression of the melting point was observed after mixing with a sample of claviformin.

It has recently been shown that the antibiotic patulin, isolated by Birkinshaw *et al.*[4] from culture filtrates of *Penicillium patulum*, is identical with claviformin[5,6]. The antibiotic isolated by Wiesner[7] from culture filtrates of *Aspergillus clavatus* is also identical with claviformin[6]. Thus claviformin is now known to be produced by at least four fungal species.

One of us (F. J. P.) is indebted to the Agricultural Research Council for a personal grant.

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Jan. 3.

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Use of Casein Hydrolysate in Experiments on the Nutrition of *Lactobacillus casei*

FOR some considerable time work has been going on in these laboratories on the nutritional requirements of *Lactobacillus casei*. Besides the known vitamins of the B-complex there are at least two other factors involved. These are present in the water-soluble portion of whole liver, and endeavours are being made to purify and isolate these active components.

During this work difficulty has been encountered as the active fractions become more purified, owing to the removal of other necessary nutritional requirements. It has always been appreciated in these laboratories that results using casein hydrolysate were not comparable to those given by pure amino-acid media, and prior to 1939 all work on microbiological nutrition was carried out on media of known composition. Owing to war conditions and the difficulty of obtaining adequate supplies of pure amino-acids, it has become necessary to work so far as possible with a medium based on casein hydrolysate, prepared

according to the directions of Mueller and Johnson[1]. When this is used as a source of amino-acids, it is found that besides the addition of tryptophane and cystine, the presence of leucine and *iso*leucine gives a considerable improvement in the growth and acid production obtained (cf. Happold[2] on the necessity of *iso*leucine in toxin production by *C. diphtheriæ*). An increase of 15–30 per cent in acid production has been noted. The relative insolubility of these amino-acids makes it probable that they are readily removed both from the casein hydrolysate and from the liver fractions.

On further purification, liver concentrates are obtained, for which the activity is improved by the addition of threonine. As an example it may be quoted that the activity adsorbed on, and eluted from, dialysed iron, requires threonine added to the medium. In some cases an increase in growth of up to 60 per cent has been recorded. Even with the addition of leucine, *iso*leucine and threonine, the blanks were completely negative, while with some of the more active liver concentrates, an acid production of 25 ml. 0·1 N. per 20 ml. medium has been obtained.

Consequently, when protein hydrolysates are used as the basis of media for assay work on the nutrition of *L. casei*, it is considered advisable to determine the threshold optimum for the addition of these amino-acids to the medium employed. Normally they are added to the media used in these laboratories at a level of 0·01 per cent (w./v.). (1·0 ml. of a 1 per cent solution to a litre of medium.)

We wish to thank Messrs. Roche Products, Ltd., for a grant to this department, enabling us to carry out these investigations.

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Origin of the Solar System

SIR JAMES JEANS[1] returns to his original form of the tidal theory, in which the sun at the time of disruption was distended beyond the orbit of Uranus. As I was responsible for the modification that required the sun to have had approximately its present size at the time, perhaps my reasons may be restated.

There appears to be no astrophysical evidence that stars of the mass of the sun can have anything like the distension required by Jeans's theory. This might possibly be met on Lane's law by the low rate of radiation of a star at such distension, supposing it still gaseous; if there were such stars, they would probably be invisible. But I do not see how my mechanical objection can be met. We should have to provide an explanation of how the orbits of the planets could be reduced to their present sizes. They would still have to miss the sun on their first perihelion passage to avoid re-absorption; and nothing but a resisting medium seems capable of reducing the mean distances. But then we meet a dilemma. Either the medium would be revolving at nearly the same rate as the planets and would have no effect on their mean distances, or it would revolve more slowly and its density would be too small at large distances to produce any appreciable effect.

The time-scale affords a further difficulty. The age of the earth appears to be limited to 3×10^9 years at the outside, and if this datum is combined with the mass-luminosity relation, it leads directly to the result that the sun could not have been much larger than at present.

I think that the most serious difficulty of all catastrophic theories, affecting both Jeans's theory and mine, and also Lyttleton's further modification, is that the newly formed planets would need to be able to control not only the velocities of thermal agitation but also those of general expansion due to the sudden relief of pressure. I have offered some suggestions about this, but am not particularly satisfied by them. Low temperature does not appear to help.

What seems to me particularly important in the present state of the subject is to have some idea of the vapour pressures of ordinary solids at temperatures far below their boiling points. It seems clear that the majority of satellites and asteroids could not have condensed from the gaseous state under gravitation alone. But if the temperature was low enough for the saturation pressure to fall below the actual pressure, condensation would take place anyhow. If this was true in Jeans's distended star, the star would consist of dust instead of gas. In the later development of planets and satellites we have to consider densities of a resisting medium of the order of 10^{-15} gm./cm.^{3} at temperatures ranging from 100° to 400° absolute. If the density was above that of saturated vapour at the temperature considered, there would be accretion, and satellites could grow no matter how small they were; if not, their gravitational attraction would never produce more than an atmosphere. I think that the data required could be calculated, but have not been able to find them in any work that I have consulted.

HAROLD JEFFREYS.

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Cambridge.

[1] NATURE, 149, 695 (1942); 152, 721 (1943).

THE theory outlined by Dr. H. Alfvén[1] appears to overlook an essential factor in the problem of astronomical evolution. At the present time the distance of the planet from the sun is determined by the fact that it possesses a certain endowment of energy and angular momentum.

If the scattered material from which Jupiter is assumed to have been evolved was initially endowed with this angular momentum, then any effect produced by electromagnetic forces must be regarded as purely temporary and is therefore irrelevant to the main issue. On the other hand, if it is suggested that the angular momentum was acquired during the process of condensation, it is necessary to describe and explain the mechanism by which the transfer of angular momentum was effected. If the angular momentum cannot be accounted for, the theory breaks down.

If it is assumed that the galaxy consisted originally of a cloud of scattered material in the form of gas, dust and small solid particles, and that the stars, planets and satellites have been evolved by a process of condensation from this material, then an adequate theory of astronomical evolution must explain three things: (1) why the angular momentum of the solar system is so much less than the angular momentum of an equal mass of the original cloud; (2) why

the angular momentum (per unit mass) of the sun, referred to the centre of the system, is so much less than that of the planets; and (3) why the angular momentum (per unit mass) of a planet, such as Jupiter, referred to the centre of the planetary system, is so much less than that of its satellites.

K. E. EDGEWORTH.

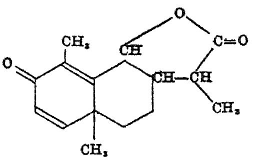
Cherbury, Booterstown,
Co. Dublin. Dec. 24.

[1] NATURE, 152, 721 (1943).

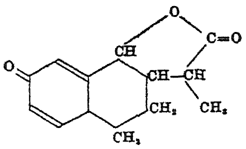
A Case of Total Asymmetric Synthesis

WE have recently announced a successful synthesis of santonin (I)[1]. We believed then that it was racemic. We have since found it to be optically active. The synthetic specimen has a rotation of $[\alpha]_D = -150$ add m.p. 171°. Sodium santoniate prepared from this sample was fractionally precipitated as the strychnine salt. This salt on decomposition gave santonin with $[\alpha]_D = -172$ identical with the rotation of natural santonin. The filtrates gave another product with identical m.p. (171°) and rotation $[\alpha]_D = -108$, which was not changed on further fractional precipitation by strychnine or quinine hydrochloride, but in no case was a dextro-rotatory product obtained. So far as we are aware, this is the first total asymmetric synthesis, apart from asymmetric synthesis carried out in the presence of polarized light, etc.

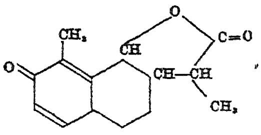
We have also prepared compounds II, III, IV and V. It has been found that asymmetric synthesis occurred only in those compounds (I, IV and V) which had an angular methyl group. The others were racemic and could be resolved into *d*- and *l*-forms through their strychnine salts.



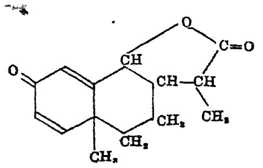
I



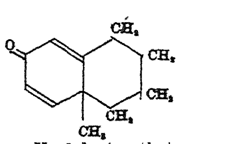
II *d*-form $[\alpha]_D = +112$
l-form $[\alpha]_D = -112$



III *d*-form $[\alpha]_D = +158 \cdot 4$
l-form $[\alpha]_D = -158 \cdot 35$

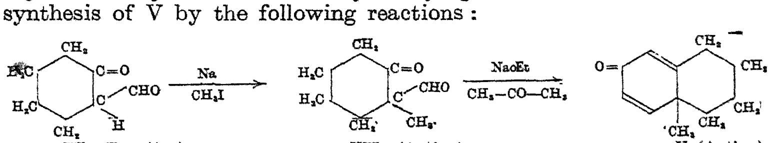


IV $[\alpha]_D$ (synthetic specimen) $= -108$



V $[\alpha]_D$ (synthetic specimen) $= -55 \cdot 65$

We have also determined the stage at which the asymmetric synthesis occurs by carrying out the synthesis of V by the following reactions:



VI (Inactive) VII (Active) V (Active)

VII is an unstable liquid and cannot be purified by distillation, and also its solid derivative could not be prepared. However, the crude substance had an optical rotation $[\alpha]_D = -26 \cdot 22$. The corresponding methylated formyl derivative used in the synthesis of santonin could not be examined for optical activity as it was highly coloured. Methylation of the formyl cyclohexanone or the corresponding derivative appears to be the stage at which the asymmetric synthesis occurs.

All rotations have been determined in chloroform solution at 28° C.

Further work is in progress.

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[1] *Current Science*, 12, 153 (1943).

Aerial Disinfection

THE letter from workers at the National Institute of Medical Research[1] was of interest to us, as we also find that lactic acid is an effective bactericidal aerosol, when the test organism is *C. xerosis*, emulsified in sterile saliva.

Bechhold[2] long ago advocated the use of hydroxy and carboxylic acids as germicidal aerosols. We found cinnamic and benzoic acids (both constituents of Peru balsam[3]) to be strong aerial bactericides, but acids, such as citric, fumaric, maleic, malic and phthalic tested recently proved relatively ineffective. On the other hand, maleic and phthalic anhydrides were found to be more active than their corresponding acids. In a concentration of 4 mgm./m³. and a relative humidity of about 60 per cent, maleic anhydride generally sterilized the air of our test organism within five minutes; the durability of lethal effectiveness being good, a 15-minute old mist only allowing survival of some 5 per cent of the bacteria beyond the 5-minute exposure time.

As regards the amount of germicide necessary to sterilize or nearly sterilize the air of our test organism within 5 minutes, it was found that of fifteen phenolic compounds examined, each required the vapour concentration to be of the order of 25 per cent saturation. Saturation at 20° C. was calculated from the vapour pressures deduced from the formula of Clausius and Clapeyron (which can be expressed as $\log p = A + B/T$, where A and B are constants). Other substances, for example, mercuric chloride, propylene and diethylene glycols, apparently require to be of an approximately similar concentration. Notable exceptions are iodine and maleic anhydride (below 1 per cent), suggesting that the mechanism of the lethal effect here is different from that of the phenols. It will thus be understood that while we see no reason to alter our opinion[4] regarding the fundamental importance of the vapour pressure of phenols in relation to activity on air-borne bacteria, it appears that this particular characteristic is not a reflexion of the activity of all groups of substances. Again, we do not consider water solubility an essential

characteristic, seeing that the fifteen phenols tested varied greatly in this respect.

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Portslade Research Laboratories,
South Street, Portslade,
Sussex. Jan. 6.

[1] NATURE, 153, 20 (1944).
[2] British Patent No. 472,623 (1935).
[3] *J. Hygiene*, 41, 121 (1941).
[4] *J. Hygiene*, 40, 342 (1940).

Occurrence of Strontium in Molluscan Shells

ATTENTION was recently directed to the possible role of small quantities of strontium carbonate in promoting the formation of aragonite, rather than calcite, in certain molluscan shells[1]. At that time the presence of traces of strontium had been demonstrated in only a few species of bivalves with aragonite shells (namely, *Tellina tenuis*, *T.* (*Macrotoma*) *baltica* and *Donax vittatus*), while the absence of strontium from some examples of the calcite shell of *Ostrea edulis* was also recorded.

I have lately had an opportunity of examining spectroscopically the occurrence of strontium in a number of other shells. It may be useful to record these results. The presence of strontium has been noted in the aragonite shells of the following species: *Venus gallina*, Gower, South Wales; *Lutraria elliptica*, Clyde; *Ceratisolen legumen*, South Wales; *Arca tetragona*, Naples (traces only); *Mactra stultorum*, South Wales (traces only); *Tellina fabula*, Aberdeen (traces only); *Cyprina islandica*, Clyde; *Pholas crispata*, ? Clyde; *Tapes aureus*, West Loch, Tarbert; *Dentalium entalis*, ? Inner Hebrides; *Nautilus* sp.; *C. edule*, Fairlie, Clyde, Scilly Isles, South Wales (traces only); *C. edule*, Cannes (more distinct).

No evidence of strontium was observed in the following aragonite shells: *Cardium echinatum*, Clyde; *Nucula tenuis*, Clyde; *Unio* sp., New Zealand: *Dreissensia polymorpha*, canal at Possil, Glasgow.

No evidence of strontium was obtained in the calcite shell *Anomia ephippium* from the Clyde. Slices of two species, *Mytilus edulis* from the Clyde, and *Pecten varius* from the Clyde, which include layers of both calcite and aragonite were examined, the layers being crushed together. No trace of strontium was obtained in either species.

It may be concluded that small traces of strontium are commonly found in shells consisting of aragonite, but that its occurrence is not universal, and though it may be one of the factors leading to the formation of aragonite, other factors must also be involved. Comparatively few calcite shells have yet been examined, but no evidence of strontium has been obtained in any of them.

My thanks are due to Prof. E. Hindle and Mr. R. Elmhirst for some of the material examined, and to Prof. J. W. Cook for facilities for spectroscopic examination.

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[1] Trueman, E. R., *J. Roy. Mic. Soc.*, 62, 69 (1942).

Achilles and the Tortoise: a Variant

ZENO's famous paradox might perhaps be used in the following way to enliven young aspirants condemned to listen to a bald narration of the peculiar virtues of the exponential function. Assuming Achilles to give the tortoise a flying start of 10 units and to move always ten times as fast as the tortoise, every schoolboy (untroubled by the infinite divisibility of space and time that formed the basis of Zeno's argument) knows that Achilles will overtake the tortoise when the latter has moved $1\frac{1}{9}$ units from its starting-point, and that this result is independent of the absolute and constant speeds of Achilles and the tortoise. Now for the enlivenment (?). Let us suppose that both Achilles and the tortoise suffer from immediate and continuously increasing fatigue, in such a manner that $v_T = pe^{-\lambda t}$, $v_A = 10pe^{-\lambda t}$. It will be observed that the initial ($t = 0$) speeds are p and $10p$ respectively, and that Achilles *always* moves ten times as fast as the tortoise (p and λ are finite positive constants, t denotes time from the start, and the suffixes A and T refer to Achilles and the tortoise respectively). Supposing Achilles to give the tortoise a flying start of 10 units, and t_m to be the time interval from the flying start when Achilles overtakes the tortoise; then

$$10p\int_0^{t_m} e^{-\lambda t}dt - p\int_0^{t_m} e^{-\lambda t}dt = 10.$$

This equation reduces to $e^{-\lambda t_m} = \dfrac{9p - 10\lambda}{9p}$, so that $t_m = \infty$ if $9p = 10\lambda$ or $\lambda = 0 \cdot 9p$. Hence, if the latter relation holds between the constants λ and p, Achilles will, in ordinary language, never overtake the tortoise. It will be observed, however, that even in the infinite limit, the distance traversed by the tortoise would still be $1\frac{1}{9}$ units, since this distance is p/λ when $t_m = \infty$. In order to avoid undue levity among the aspirants, it might be better to substitute a second tortoise for Achilles.

F. G. DONNAN.

The Athenæum,
London.

Post-War University Education

MR. HARDIE's valuable letter in NATURE of January 8 mentions the proposal of the British Association Committee on Post-war University Education that English universities should offer, in addition to the existing specialized Honours Schools, a general honours course in "philosophy, natural and social". Mr. Hardie truly observes that the new discipline would not solve the difficulty of ensuring that students in existing honours groups should acquire "a more balanced and mature mental outlook". But the Committee is now engaged upon this problem; and the draft of a section of its final report, suggesting how the problem might be solved, is to be considered at the next meeting of the Committee. This draft has a good deal in common with Mr. Hardie's own proposal.

MAXWELL GARNETT
(Chairman of the B.A. Committee on Post-war University Education).
British Association,
Burlington House, London, W.1.

AN UNAMBIGUOUS METHOD OF AVOIDING DIVERGENCE DIFFICULTIES IN QUANTUM THEORY

By PROF. E. C. G. STUECKELBERG
University of Geneva

THE classical theory of a point charge and the quantum theory of wave packets contain in their usual form well-known divergences. Dirac[1] has elaborated a classical particle theory which avoids these difficulties, but his results cannot as yet be applied to quantum theory. On the other hand, Heisenberg[2] has recently proposed a new formalism which permits the calculation of collision cross-sections in quantum theory without being disturbed by diverging terms. However, no connecting link such as the correspondence principle has been given in order to apply this quantum formalism to a given problem such as Rutherford scattering, Compton effect or radiation damping.

Dirac's theory being well known, we content ourselves with recalling briefly the general idea of Heisenberg's description of collision phenomena. If no reaction between particles takes place, the behaviour of the system of particles can be described by a plane wave in configuration space $\Psi^{(0)}$. Such a wave can always be decomposed into an incoming $\Psi^{(0-)}$ and an outgoing $\Psi^{(0+)}$ spherical wave. If reactions take place, the number of particles scattered in a given direction (as observed by an observer at infinite distance from the collision region) is determined by a change of phase in the outgoing wave. This effect is described by a unitary phase operator $e^{-i\eta}$ determining the true outgoing spherical wave $\Psi^{(+)} = e^{-i\eta}\Psi^{(0+)}$ at infinity. The operator η must be Hermitic and relativistically invariant. Applying the method to quantized fields $u(\vec{x},t)$, Heisenberg discusses the effects due to η values of the form

$$\eta = \varepsilon \int_{-\infty}^{+\infty} dt \int (dx)^3\, u\left(\vec{x},t\right)^n.$$

If u is written as a series
$u = \Sigma\, (2Vk^4)^{-\frac{1}{2}} (a_k \exp(i(k,x)) + a_k^* \exp(-i(k,x)))$
with $(k,x) = (\vec{k},\vec{x}) - k^4 t$, $k^4 > 0$, the operator η has to be chosen so that all the a^*'s stand left of all the a's. This rule is invariant and prevents singularities from occurring. The space-time integral guarantees the invariance of the formalism and implies the usual conservation laws of energy (k^4) and momentum $\vec{k}$. No description for finite distances is possible in this theory.

We have succeeded in connecting the usual quantum theory to the Heisenberg formalism, and the result is but the logical translation of Dirac's classical theory into quantum language. Our method will best be understood in the following example: Let $u(x) = u(\vec{x},t)$ be a field of matter (particles) the wave packets of which follow the same world-lines $x^\alpha = q^\alpha(\lambda)$ as the particles do. If $m\,\ddot{q}_\alpha = \varepsilon\partial\varphi/\partial q^\alpha$ is the differential equation of the corresponding particles in a given field of force $\varphi(\vec{x},t)$,

$$(\Box - (m^2 - 2\varepsilon m\varphi))\,u = 0 \qquad (1)$$

is the wave equation. The reaction on the field φ is described by

$$(\Box - \varkappa^2)\,\varphi = -\rho;\ \rho = \varepsilon m u^2;\ (\text{or} = \varepsilon \int d\lambda\, \delta(x - q(\lambda)))\ . \qquad (2)$$

In quantum theory we treat both u and φ as operators, developing them into series with a_k^*, a_k (for u) and b_μ^*, b_μ (for φ). Thus, the explicit time dependence of u and φ is given by $(\Box - m^2)u = (\Box - \varkappa^2)\varphi = 0$, while the true time derivative $\dot{u}$ follows from a canonical formalism

$$\dot{u} = \frac{\partial}{\partial t} u\left(\vec{x},t\right) + i\varepsilon\left[H(t), u\left(\vec{x}\,t\right)\right];$$
$$\varepsilon H(t) = \varepsilon m \int (dx)^3 \varphi u\left(\vec{x},t\right)^2 \qquad (3)$$

This expression (3) and the explicit time dependence of the operators are equivalent to (1) and (2). In order to apply our theory to an actual problem, we have to express the Schrödinger probability amplitude $\Psi(t)$ in terms of the probability amplitude $\Psi(-T)$ at a time $t = -T$ before the collisions have occurred ($\lim T = \infty$). Quantum theory proceeds as follows: the Schrödinger differential equation

$$\frac{\partial\Psi(t)}{\partial t} = -i\varepsilon\, H(t)\, \Psi(t) \qquad (4)$$

is solved by successive approximations in ε. We try, however, the solution

$$\Psi(t) = e^{\alpha(t)}\, \Psi(-T). \qquad (5)$$

Substituted into (4), it leads to the integral equation $(\partial\alpha/\partial t \equiv \dot{\alpha})$

$$-iH(t) = \dot{\alpha}(t) + \frac{\varepsilon}{2!}[\alpha, \dot{\alpha}] + \frac{\varepsilon^2}{3!}[\alpha,[\alpha,\dot{\alpha}]] + \ldots \qquad (6)$$

In order to obtain a solution for the unknown operator $\alpha(t)$ ($\alpha(-T) = 0$), we develop $\varepsilon\alpha$ in the following series $\varepsilon\alpha = \varepsilon\alpha^{(1)} + \varepsilon^2\alpha^{(2)} + \varepsilon^3\alpha^{(3)} + \ldots$

The first terms are

$$\begin{aligned}
\varepsilon\dot{\alpha}^{(1)} &= -\,i\varepsilon H(t) \\
\varepsilon^2\dot{\alpha}^{(2)} &= -\frac{\varepsilon^2}{2}[\alpha^{(1)}, \dot{\alpha}^{(1)}] \equiv \varepsilon^2 \alpha \overset{(2)}{R} + \varepsilon^2 \alpha \overset{(2)}{C} \\
\varepsilon^3\dot{\alpha}^{(3)} &= -\frac{\varepsilon^3}{2}[\alpha^{(2)}, \dot{\alpha}^{(1)}] - \frac{\varepsilon^3}{6}[\alpha^{(1)}, \dot{\alpha}^{(2)}]
\end{aligned} \qquad (7)$$

etc. Integrating from $-T$ to t and applying the usual commutation rules ($[u(x), u(y)] = iD(x-y)$), the first terms are

$$\begin{aligned}
\varepsilon\alpha^{(1)} &= -\,i\varepsilon m \int_{-T}^{t} dt \int (dx)^3 u^2\varphi\left(\vec{x},t\right) \\
\varepsilon^2\alpha \overset{(2)}{R} &= -\,i\,\frac{\varepsilon^2}{2} m^2 \int_{-T}^{t} dt \int (dx)^3 u\left(\vec{x},t\right)^2 \operatorname{ret}_{(\varphi)}(u^2) \qquad (8) \\
\varepsilon^2\alpha \overset{(2)}{C} &= -\,i\varepsilon^2 m^2 \int_{-T}^{t} dt \int (dx)^3 u\varphi\left(\vec{x},t\right) \operatorname{ret}_{(u)}(u\varphi) \\
\varepsilon^3\alpha^{(3)} &= -\,i\varepsilon^3 m^3 \int_{-T}^{t} dt \int (dx)^3 (u\left(\vec{x},t\right)^2 \operatorname{oper}(uu\varphi) + \ldots).
\end{aligned}$$

$\operatorname{ret}_{(\varphi)}(\rho)$ is the retarded potential of a charge density ρ in (2), oper (ρ) is another more complicated integral operator. After developing u and φ in terms of the a, a^* and b, b^* operators, we can, as did Heisenberg, interchange their order so as to have all a^*, b^* left of the

a,b. This change corresponds to an invariant subtraction of all diverging terms; the term $a^*_{k''}a_{k'}\,a^*_{k'}\,a_k$ in $\alpha_C^{(2)}$ contributes to the 'Coulomb' self-energy of the u-particles. The other terms of $\varepsilon^n\alpha^{(n)}$ correspond to the transition-probabilities for collisions in which $n + 2$ particles take part (in the sense of chemical reactions). For example, $\varepsilon^2\alpha^{(2)}{}_R$ contains the term $a^*_{k'''}a^*_{k''}a_{k'}a_k$, where two particles with the momenta k and k' disappear and two particles of momenta k'' and k''' are created. This is Rutherford scattering (if φ is the electromagnetic field) and $\varepsilon^2\alpha^{(2)}{}_C$ contains the Compton effect $(a^*_{k'}b^*_{\mu'}a_kb_\mu)$, where a φ-quantum of momentum μ collides with a u-particle of momentum k. The terms in $\varepsilon^3\alpha^{(3)}$ contain the *Bremstrahlung* $(a^*_{k'''}a^*_{k''}\,b^*_\mu a_{k'}a_k)$, where, in addition to the Rutherford scattering, a μ-quantum is created.

Putting $t = +T$ and passing to $T \to \infty$, our theory takes the Heisenberg form. However, we have unambiguously determined the Hermitic Heisenberg operator $\eta = i\varepsilon\alpha(\infty)$ and, furthermore, for any given t, we can describe the quantum mechanical state of the system.

We can arbitrarily change the numerical coefficients of each individual $\varepsilon^n\alpha^{(n)}$ (or of their invariant parts) without destroying the conservation laws or the invariance. For example, a theory which contains only $\varepsilon\alpha = \varepsilon^2\alpha^{(2)}R$ and nothing else shows Rutherford scattering but no radiation effects (no Compton effect and no *Bremstrahlung*, etc.). But such a theory is possible even classically. Consider a system of particles, where the force acting upon any one of them is the mean value between the advanced and retarded effect of all other particles. Such a theory is invariant and conserves energy and momentum, but it is not conformal to our causal representation of phenomena. The same acausal behaviour is contained in the quantum mechanical $\Psi(t)$. There exists now a finite probability that a quantum appears at a certain event $(\vec{x},t)$, without a finite probability that a cause has occurred at a preceding event in the invariant past of $(\vec{x},t)$. In electrodynamic phenomena, the causal behaviour has been experimentally checked. Therefore, our theory is unambiguous if applied to quantum electrodynamics. Applied to nuclear forces, however, we have great liberty in the choice of $\varepsilon\alpha$ (or of Heisenberg's η) if we go back to a causal description at small distances. But one must say that it is not necessary to go back to causal description even for distances of 10^{-13} cm.

We have applied our theory to the case of line width. A classical point particle with an internal (scalar) degree of freedom (τ, ρ, σ) treated according to Dirac's method leads to

$$\ddot{\tau} + \frac{1}{2\pi}\,\varepsilon^2\mu_0\,\sigma\dot{\tau} + \mu_0{}^2\tau = \varepsilon\sigma\,\varphi\,(q(\lambda))^{\text{inc}};\ \dot{\sigma}\sim 0.$$

Its line broadening due to radiation damping is (if $\sigma = +1$ and $\varkappa = 0$) therefore

$$J(\mu) = \gamma^2\,((\mu - \mu_0)^2 + \gamma^2)^{-1};\ \gamma = \frac{\varepsilon^2}{4\pi}\,\mu_0. \qquad (9)$$

The corresponding quantum mechanical model is given by two fields of matter u and v the rest masses of which differ by $m_v{}^2 - m_u{}^2 \cong 2m\mu_0$. With $\varepsilon H = 2\varepsilon m\int(dx)^3 uv\varphi$, only particles of mass $m_u (< m_v)$ are stable (analogous to $\sigma = +1$ in classical theory). Excitation of the u-particle into the v-state and subsequent emission of a φ-quantum, or the dispersion of a φ-wave produces φ-quanta of frequency μ with a probability given by

$$J(\mu) = \left(\sin\frac{\gamma}{\mu - \mu_0}\right)^2;\ \gamma = \frac{\varepsilon^2}{4\pi}\,\mu_0 \qquad (10)$$

instead of (9). This is a rigorous solution of the quantum-mechanical problem. The approximate treatment of Wigner and Weisskopf[3] leads to (9). Total intensity of the emitted light and the dispersion for $|\mu - \mu_0| \gg \gamma$ are, however, the same.

[1] Dirac, *Proc. Roy. Soc.*, A, 167, 148 (1938).
[2] Heisenberg, *Z. Phys.*, 120, 513 and 673 (1943).
[3] Weisskopf and Wigner, *Z. Phys.*, 63, 54 (1930).

BEHAVIOUR OF THE SONG SPARROW AND OTHER PASSERINES

MRS. NICE is well known to ornithologists as an indefatigable and scientific observer, whose previous detailed studies on the song sparrow (*Melospiza melodia*), published in 1937 as vol. 4 of the *Transactions of the Linnæan Society of New York*, had shed new light on the detailed behaviour of particular individuals of a particular bird species in Nature, as well as extending our general ideas on the territory theory. In a second work* she brings together under their various heads the behaviour traits of the song-sparrows she has watched in Nature and those she has hand-reared herself (all her observations concern colour-banded and therefore individually recognizable individuals), together with a vast amount of data on other species from the recent literature. Thus we have here one of the first essays in the comparative study of avian behaviour.

The result is of great value. Methodologically it is of interest as a crowning demonstration of the fact that field observation, if properly carried out, is an essential tool of biological science: laboratory research could never have elicited the facts and principles here set before us. It is also a reminder for the average biologist that the principles of vertebrate behaviour are now emerging with some clarity, thanks very largely to the labours of field ornithologists, and that they are in many ways unexpected and of great general interest.

It is impossible in the space available to give a critical review, and I must confine myself to citing some of the chief topics covered by Mrs. Nice, with the reminder that in each case she gives a balanced discussion of her own and others' findings.

These topics include an attempt to disentangle innate and acquired factors in bird behaviour (which leads to somewhat surprising results); a general discussion of Lorenz's basic theories of *releaser* or *signal* stimuli, and of the role of the *Kumpan* (or fellow-member of the same species) in the social life of birds; an account of the genetic psychology of passerine birds from hatching onwards; waking and sleeping times in relation to twilight; a discussion of the dominance and subordination relations of passerines; 'symbolic' actions; song; territory; habitat selection; a general analysis of the difficult problems of pair-formation; courtship; injury-feigning; enemy recognition; individual variation in behaviour.

* "Studies in the Life History of the Song Sparrow (2). The Behavior of the Song Sparrow and other Passerines". By Mrs. M. M. Nice. (*Trans. Linn. Soc., N.Y.*, 6, Sept. 1943, pp. viii+329.)

In regard to this last point, Mrs. Nice makes it clear that every individual male song-sparrow has his own repertoire of songs, all of them readily distinguishable, with a little practice, from those of all other males. The number of separate songs in a cock bird's repertoire varies from six to twenty-four. One male song-sparrow sang from 4.45 a.m. to 7.43 p.m., giving 2,305 songs in fifteen hours, with 278 songs as his highest rate per hour!

Again (as Lack has since shown in the English robin) migration is a matter of individual variation; and indeed birds that migrate one year need not do so the next.

There are a few criticisms to be made. Among several misprints (including some, such as the transposition of lines on p. 64, which one does not expect to find in a scientific publication), there is one serious one in Table 13 where *songs* should apparently be *song-series*; and in Table 5, the "group V" discussed in the text is omitted. Although a great volume of literature is comparatively reviewed, there are some curious and unexplained gaps. Thus, though Lloyd Morgan's fundamental "Habit and Instinct" and Kirkman's recent important studies on egg and nest-site recognition are cited in the literature list, they appear to be neglected in the discussion. The important work of Lockley on homing and other activities in shearwaters is entirely omitted, together with the numerous data of various authors on the behaviour of the gannet, and the valuable work of Nicholson and Koch, complete with gramophone records, on the song of British birds. More generally, the sections on courtship and display might have been fuller, with more weight given to studies on other forms, notably non-passerines.

These, however, are mere minor omissions. The work as a whole is a monument of industry and a model of method. If the author appears to go a little far in claiming (p. 273) that "the study of animal behavior is the only and ultimate source of understanding ourselves", it is certainly true that it is an indispensable aid in that task, and further that it reveals unexpected aspects of mental evolution which even the most complete study of our own psychological organization could not have made available. In any event, in this and the preceding work, Mrs. Nice has made a massive and outstanding contribution to our advancing knowledge of animal behaviour. JULIAN HUXLEY.

OX BLOOD FOR BLOOD TRANSFUSION

MANY people must have wondered whether some use could not be made of the large quantities of ox blood available in our slaughter-houses. If the conclusions drawn by Dr. Edwards (*Brit. Med. J.*, Jan. 15, 1944) and his collaborators survive the further tests to which they are being subjected, the ox of the future may not only give his life and meat for man, but may serve him also with his very blood and may be kept for that purpose by the community.

The use of plasma for surgical treatment is, as Dr. Edwards points out, increasing rapidly, and the search for a suitable plasma other than that provided by the blood banks is in progress. It would seem that the collaboration between Dr. Edwards and the Regional Transfusion Laboratories, the North Staffordshire Royal Infirmary and experts at Cambridge and Liverpool, has gone a long way towards the solution of this problem. The substitutes for human plasma which have been tried have not, Dr. Edwards states, possessed the three characteristics that are necessary, namely, that they should be retained in the circulation and should eventually be metabolized, that they should exert an osmotic pressure equivalent to that of the plasma and that they should be non-toxic, free from antibodies and non-antigenic. Bayliss in 1916 tried 6 per cent gum acacia in saline for the treatment of shock, but this was only partially metabolized and much of it remained in the tissues with unpleasant consequences. Other substances mentioned by Dr. Edwards may maintain the blood-pressure in shock and hæmorrhage, but they do not restore the blood protein. Animal plasma protein most nearly resembles human plasma protein, and the total protein of bovine blood most nearly approaches that of human blood; but it contains a much higher percentage of fibrinogen. Further, its albumin/globulin ratio is lower, so that bovine blood might exert a lower osmotic pressure, because the albumin fraction exerts the greater pressure. Bovine blood is, however, available in practically unlimited quantities.

It has been shown that crude bovine serum is unsuitable. Dr. Edwards outlines the attempts to overcome such difficulties as the serum sickness which it causes and the tendency to hæmolysis of the human red cells and the slow rate of administration. He explains in detail the method which he and his collaborators have finally adopted for the preparation of a bovine serum which has been tested on twenty-six cases. The method includes the heating of the serum to 72° C. to destroy the antibodies and the addition of 0·2 per cent of formalin and ammonia to render the proteins uncoagulable. He claims that the serum obtained fulfils the requirements indicated above.

The final product is called D.B.S. (despeciated bovine serum). It has an osmotic pressure comparable to that of filtered human plasma. It was kept for six months in Dr. Edwards's car and was then given to a patient without untoward results; after nine months in a refrigerator it had not deteriorated. It can, moreover, be given very rapidly and in large amounts. After a preliminary trial on twenty-six patients, Dr. Edwards claims that it is safe to give it to man and that it is well retained in the circulation. It is easily prepared in large quantities.

The possibility of the transmission by it of tuberculosis or of *Brucella abortus* has been considered. Dr. Edwards advocates bleeding from tuberculin-tested stock only; or only from bullocks and heifers, because only 6 per cent of these coming to the slaughter-house are infected with tuberculosis or *Brucella abortus*, whereas the rate among slaughtered cows is 30 per cent. If the meat inspector reports gross tuberculous infection of the carcass, the blood taken from that animal should be discarded. But the Seitz filtration during the process of manufacture should, Dr. Edwards thinks, remove any of these organisms that may be present in the blood.

Before he gives a final judgment, Dr. Edwards wisely awaits the results of more detailed hæmatological and biochemical work on the effects of the administration of despeciated blood serum to patients in states of shock, hypoproteinæmia and protein deprivation and loss. G. LAPAGE.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, January 29

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (joint meeting with the ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY) (at 16 Princes Gate, South Kensington, London, S.W.7), at 2.30 p.m.—Symposium on "Micro-densitometry and Micro-sensitometry".

Tuesday, February 1

INSTITUTE OF FUEL (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Mr. Harold Moore: "Liquid Fuels and Organic Chemicals from Coal and Home-Refined Petroleum".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. D. Kay: "Modern Developments in Dairy Science", ii. "Milk Production and Livestock Problems".*

INSTITUTION OF CIVIL ENGINEERS (ROAD ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. R. U. Law: "Modern Plant and Road Construction".

Wednesday, February 2

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. E. C. Goldsworthy: "Light Alloys in Post-War Britain".

Thursday, February 3

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "The Strategy and Tactics of Crystal Structure Analysis by X-Rays".*

KING'S COLLEGE (in the Department of Electrical Engineering, Strand, London, W.C.2), at 3 p.m.—Mr. W. D. Horsley: "Turbo Generator Practice".*

Friday, February 4

SOCIETY OF CHEMICAL INDUSTRY (MANCHESTER SECTION) (joint meeting with the NORTHERN BRANCH OF THE INSTITUTE OF PETROLEUM) (at the Grand Hotel, Aytoun Street, Manchester), at 2.30 p.m.—Dr. F. King: "Petroleum Refining—a Chemical Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. E. D. Adrian, O.M., F.R.S.: "Brain Rhythms".*

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Mr. S. Booth: "The Electrical Equipment of Ships".

Saturday, February 5

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10.30 a.m.—Conference on "Budgetary and Dietary Surveys of Families and Individuals", Part 1.

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Sir Edmund O. Teale: "The Geology and Scenery of Tanganyika Territory, East Africa".

INSTITUTE of PHYSICS (MANCHESTER AND DISTRICT BRANCH) (at the Christie Hospital and Holt Radium Institute, Wilmslow Road, Withington, Manchester), at 2.30 p.m.—Prof. W. V. Mayneord: "Physical Principles of X-Ray Therapy".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ORGANIZER OF AGRICULTURAL EDUCATION—The Secretary for Education, County Hall, Ipswich (February 1).

ASSISTANT HORTICULTURAL OFFICER (temporary)—The Executive Officer, Berkshire War Agricultural Executive Committee, 1 Abbot's Walk, Reading (February 4).

ASSISTANT (temporary) TO THE ADVISORY BACTERIOLOGIST—The Secretary, Edinburgh and East of Scotland College of Agriculture, 13 George Square, Edinburgh (February 5).

LECTURER IN CHEMISTRY—The Clerk and Treasurer, Dundee Institute of Art and Technology, Bell Street, Dundee (February 5).

PRINCIPAL of the Gloucestershire College of Domestic Science and Training College—The Secretary, County Education Office, Shire Hall, Gloucester (February 5).

CHIEF TOOL DESIGNER for service in an Admiralty Establishment in Scotland—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.1965.A.) (February 9).

METALLURGIST AND CHEMIST in a large general purpose Iron Foundry and Engineering Works in the North Midlands—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. O.N.F.1932.XA) (February 9).

LECTURER IN PHYSIOLOGY—The Registrar, King's College, Newcastle-upon-Tyne (February 9).

REGISTRAR—The Principal, University College of Wales, Aberystwyth (February 10).

TUTOR IN NATURAL SCIENCE—The Principal, Lady Margaret Hall, Oxford (February 10).

HEAD OF THE DEPARTMENT OF CHEMISTRY AND BIOLOGY of Leeds College of Technology—The Director of Education, Education Office, Leeds 1 (February 12).

INSTRUCTOR (temporary) IN TECHNICAL SUBJECTS at the Hull Nautical School and School for Fishermen—The Director of Education, Education Offices, Guildhall, Hull (February 14).

RADIOGRAPHER in charge of the X-Ray Department and PRINCIPAL of the School of Radiography—The House Governor, King's College Hospital, Denmark Hill, London, S.E.5 (February 14).

ENGINEERING LECTURER (Ref. No. C.1997A), MATHEMATICS LECTURER (Ref. No. A.422A), PHYSICS LECTURER (Ref. No. A.423A), ASSISTANT MATHEMATICS AND PHYSICS LECTURER (Ref. No. A.424A), ENGINEERING INSTRUCTOR (Ref. No. O/N.391), and a DEMONSTRATOR to assist lecturers in class work generally, for the Technical School of a Government Department located in Surrey—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Ref. No.) (February 16).

CHAIR OF BOTANY tenable at King's College, and CHAIR OF BOTANY tenable at Birkbeck College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 21).

LECTURER IN CHEMISTRY FOR MEDICAL STUDENTS—The Acting Secretary, University Court, Glasgow (February 25).

UNIVERSITY CHAIR OF ANATOMY tenable at St. Mary's Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 20).

TECHNICIAN to undertake routine preparation of slides and to assist in research in the Department of Physiology—Prof. Burns, Medical School, King's College, Newcastle-upon-Tyne, 2.

PHYSICAL-CHEMIST to work on Adhesives, and a PHYSICIST for work on the Printing Qualities of Paper—The Director of Research, Printing and Allied Trades Research Association, 101 Princes Gardens, Acton, London, W.3.

TWO ORGANIZING SECRETARIES (fluent in two languages, with science degree or scientific background)—The British Council, 3 Hanover Street, London, W.1 (marked 'Science Department').

LABORATORY ASSISTANT (male or female) (B.Sc. with a knowledge of bacteriology and chemistry preferred)—The Pathologist, Cumberland Infirmary, Carlisle.

SCIENTIFIC ASSISTANT for the East African Agricultural Research Station at Amani, Tanganyika Territory—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Order No. O.S.19).

LECTURER IN MECHANICAL OR ELECTRICAL ENGINEERING, and a SCIENCE LECTURER—CHEMISTRY and/or PHYSICS with subsidiary Mathematics, at the Swansea Technical College—The Director of Education, Education Department, Guildhall, Swansea.

GRADUATE MISTRESS (MATHEMATICS) for Barrett Street Technical School, Oxford Street, London, W.1, and Maidenhead—Application Form T.1/40 from the Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1.

PSYCHIATRIST (part-time) and an EDUCATIONAL PSYCHOLOGIST (part-time) at Child Guidance Clinics to be established by the Kent Education Committee—The School Medical Officer, Public Health Department, County Hall, Maidstone, Kent.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Memoirs of the Cotton Research Station, Trinidad. Series A: Genetics. No. 19: Colchicine-Produced Polyploids in *Gossypium*, 1: An Autotetraploid Asiatic Cotton and certain of its Hybrids with Wild Diploid Species. By S. G. Stephens. Pp. 26. (London: Empire Cotton Growing Corporation.) 2*s*. 6*d*.

Nature Conservation and Nature Reserves. Report drawn up by a Committee and approved by the Council of the British Ecological Society, October 1933. Pp. 38. (Cambridge: At the University Press.) 1*s*. 6*d*. net. [61

Lecture on 'Chemistry and Cancer'. By Dr. J. W. Cook. Pp. 36+3 plates. (London: Royal Institute of Chemistry.) [61

The Education and Training of Chemists. Report of the Chemistry Education Advisory Board. Pp. 16. (London: Royal Institute of Chemistry.) [61

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 14, No. 3, December 1942. Compiled by Agnes Elisabeth Glennie, assisted by Catherine Alexander. Pp. iv+151-226. (London: H.M. Stationery Office.) 4*s*. 6*d*. net. [61

UFAW: Universities Federation for Animal Welfare. Seventeenth Annual Report for the Year ending September 30th, 1943. Pp. 4. (London: Universities Federation for Animal Welfare.) [61

Other Countries

U.S. Department of Agriculture. Leaflet No. 236: Preventing Damage to Commercial Dried Fruits by the Raisin Moth. By Heber C. Donohue, Perez Simmons, Dwight F. Barnes, George H. Kaloostian and Charles K. Fisher. Pp. 6. 5 cents. Technical Bulletin No. 841: Life-History and Control of the Tomato Pinworm. By John C. Elmore and A. F. Howland. Pp. 30. 10 cents. (Washington, D.C.: Government Printing Office.) [41

Imperial College of Tropical Agriculture: Low Temperature Research Station. Memoir No. 19: The Respiration of Bananas during Storage at 53° F. and Ripening at Controlled Temperatures. By E. R. Leonard and C. W. Wardlaw. Pp. 379–424. (Trinidad: Imperial College of Tropical Agriculture.) [61

Annals of the New York Academy of Sciences. Vol. 44, Art. 4: High Polymers. By Raymond M. Fuoss, J. Abere, W. O. Baker, Henry Eyring, John D. Ferry, Paul J. Flory, C. S. Fuller, G. Goldfinger, R. A. Harman, Maurice L. Huggins, H. M. Hulbert, H. Mark, H. Naidus, Charles C. Price, John Rehner, Jr., Robert Simha and A. V. Tobolsky. Pp. 263–444. (New York: New York Academy of Sciences.) [121

Catalogue

CoAx Articulated Air-Spaced Cables for High Frequencies. Pp. 6. (Beaconsfield: Transradio, Ltd.)

NATURE

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RELATION OF RELIEF TO RECONSTRUCTION

THE importance of the agreement setting up a United Nations Relief and Rehabilitation Administration and defining its constitution and functions, which was signed by representatives of forty-four countries at Washington on November 9, is not easily overstressed. It is a milestone in the working out of joint post-war policy. It is the first piece of executive machinery to be established, and although it covers a comparatively limited field, it foreshadows a general pattern of post-war co-operation.

The agreement creates a Council representing all member Governments, including "national authorities" like the French, which will lay down general policies and constitute standing committees, including one on supplies, one for Europe, and another for the Far East. Of this Council Mr. Dean Acheson has been elected permanent chairman. Mr. Herbert Lehman, former governor of New York, has been appointed director-general of the United Nations Relief and Rehabilitation Administration with full power and authority to carry out the relief operations contemplated. There is a Central Committee consisting of representatives of China, the Soviet Union, Great Britain and the United States, and regional committees will be appointed by the Council as required. While the relations between the Council and this Central Committee have not yet been clearly explained, on paper the latter does not override.

The new organization is to arrange measures for the relief of war victims through the provision of food, fuel, clothing, shelter, and basic necessities generally, and medical and other essential services. Its task is thus threefold. First, the organization has to build up stores of foodstuffs and other supplies; secondly, it has to see that the available supplies are distributed equitably and efficiently as the opportunity arises; and, thirdly, it has to link relief and rehabilitation so as to encourage self-help and end the need for relief by reviving production.

The admirable series of studies recently issued by the League of Nations offers not only evidence as to the imperative need for the establishment of such an organization but also guidance and warning as to the measures to be taken. We have now an opportunity to do better than in the years following 1918 although in far worse circumstances, but only on condition that we profit by the experience so painfully gained after the last War. The stock position then was much better than it can possibly be at the end of this War: the general food shortage which threatens to face the world is far from being widely appreciated, and in addition there will probably be an acute shortage of fuel and transport. The destruction and dislocation to be overcome are on a far greater scale. It has been estimated that there will be 21,000,000 displaced people in Europe, while in Asia the numbers are even larger: evacuees in China alone have been variously put between thirty and sixty millions.

The magnitude of the task which confronts the new organization is well illustrated by a recent

report for the International Labour Office by Prof. E. M. Kulischer on "The Displacement of Population in Europe", which has just been published*. To minimize the suffering, which the report also discloses, and that which is yet to come before these victims of war can find a useful settled life in a world at peace, is at least as cogent and urgent a reason as the accelerated pace of the War to advance as much as possible our preparations to relieve the needs of the occupied countries as they are liberated. It can equally inspire that sterner and supreme effort in the prosecution of the War itself, so as to hasten the day of liberation and set the shortest possible term on the suffering involved with each day the War continues.

There could be no greater mistake than to regard the proceedings of the Conference at Atlantic City in working out the technical implications of the agreement—how much food, clothing, medical and other supplies will be needed, where they are to come from, and how they are to be allocated—as any distraction from our war effort. Such deliberations are a practical test of our fitness to win the War, of the spirit in which the nations will face the problems arising out of the War and the peace. Success can only come if political and national considerations are put firmly on one side and the supplies available made a common pool upon which the most urgent needs have the first call.

The past few months have made clear some of the difficulties that lie ahead. In place of the plentiful supplies at one time anticipated, only the most careful husbanding, especially of food, will ensure that supplies are adequate. In each country it will be necessary to control and allocate goods which are scarce, taking account of the needs of the War, of its own civilian population, and of the victims of German ruthlessness. For this reason alone the Relief Administration will require strong backing to enable it to succeed. The representatives must be men who carry weight in their own country, in order to induce their fellow-countrymen to submit to the necessary sacrifices for the common good. Every effort, too, must be made to secure the full understanding of what is involved and why such sacrifices are necessary. Firm backing will also be necessary to secure equality. Liberated countries with funds must not be allowed to secure preferential treatment over others. Countries liberated first must be prevented from scrambling for goods, to the loss of countries to be freed later.

All this implies control of imports and of shipping and much international self-denial. This cannot be expected without a carefully planned programme of education. Moreover, the Relief Administration has to continue all the work that has been done in preparing for economic rehabilitation; and the high degree of technical skill required makes it essential that it should not be starved of either staff or money. Here, as in other matters, this first concrete step in world co-operation will speedily provide a searching test of our sincerity and determination to build a better world order and to profit by past mistakes and bitter experience.

There are reasons why the United Nations Relief and Rehabilitation Administration conference somewhat overshadows the Food and Agriculture Conference at Hot Springs earlier last year. The latter was concerned with long-term post-war policies; the former is concerned with the more immediate problems that will arise, first in Europe and then in the Far East. What we have already said indicates that the new Administration may be the most important executive agency in international reconstruction. From it will proceed the first steps in international co-operation for peaceful ends. Its work is necessarily tied up with all the wider problems of agriculture, currency, commercial policy, commodity control, transport, etc., on which common action by the United Nations is planned.

It is therefore of special interest to note that the proposed organization appears to embody the functional principle advocated so ably by Dr. D. Mitrany, as well as the regional principle represented for war purposes in the Middle East Supply Council and the Anglo-American Caribbean Commission. How far this pattern may determine that of post-war international co-operation generally remains to be seen, but experience gained during the War appears to be turned to account and there is less reason to fear that, this time, machinery established to further our war effort will be scrapped without forethought. The success of this practical test of our ability to co-operate may well have a profound effect not only on co-operation in other fields but also on economic and commercial policy and post-war trade generally (see p. 159 of this issue).

A notable example of the educational work required to ensure the success of the work of the Relief and Rehabilitation Administration is provided by the symposium on post-war problems arranged last February by the American Philosophical Society*. Mr. G. S. Ford's paper, "America Enters the Scene", with its note on the need for self-education and discipline if we are to solve the problems of post-war settlement and establish an economy providing the greatest possible freedom of interchange of raw materials and the finished products of men's hands and minds, could have been delivered as pertinently to a British as to an American audience. The same might be said of F. G. Boudreau's analysis of the social and economic implications of freedom from want of food, with its reminder that adoption now of adequate nutrition policies by the Governments of the United Nations would provide an expanding market for agricultural products for years to come, and that a sound nutrition policy would increase the international exchange in foodstuffs rather than diminish it. Evidence of the attitude of the smaller nations is afforded by Alexander Loudon's paper discussing the control of German industry, Halvadan Koht's paper on "The Small Nations in the Post-War World" and Oscar Halecki's paper on the problem of self-determinism, with their emphasis on democracy and on regionalism.

* "The Displacement of Population in Europe". By Prof. E. M. Kulischer. (London: P. S. King and Staples, 1943.) 6s. net.

* *Proc. Amer. Phil. Soc.*, 87, No. 2 (August 16, 1943).

These papers, like Alexander Loveday's paper on "The Economics of Transition", show well the issues involved, and the imperative necessity of international co-operation in the formulation and execution of policies for maintaining full employment. Nor can men of science be blind to the dangers to health and the maintenance of order if we fail to provide the organization to deal with relief and rehabilitation. As the report of the International Labour Office says : "Unless there is an organisation to provide these people with means of subsistence and to give them confidence that they have not been forgotten, the highways of Europe will be blocked by long processions of destitute exiles enduring every kind of privation in an effort to return unaided to their homes".

Here is a task demanding not merely technical knowledge and first-class administration, the training of staff and the mapping out of the field ; but also something akin to an international employment service and the steady co-operation of all the United Nations. On its discharge may well depend the future of European civilization and the rebuilding of the broken centres of learning and research throughout the occupied countries.

HIERONYMUS FABRICIUS, 1533–1619

The Embryological Treatises of Hieronymus Fabricius of Aquapendente

The Formation of the Egg and of the Chick (De Formatione Ovi et Pulli), the Formed Fetus (De Formato Foetu). A facsimile edition, with an Introduction, a Translation, and a Commentary, by Prof. Howard B. Adelmann. Pp. xxiii+883. (Ithaca, N.Y.: Cornell University Press. London: Oxford University Press, 1942.) 12 dollars.

THIS learned and imposing monograph will in the course of time take its place alongside Dobell's "Leeuwenhoek" as one of the classics of the critical and historical literature of biology. We already owe to Prof. Adelmann an important study of the embryological work of Coiter, and he now deals with the similar researches of the famous Padua anatomist. It is to be hoped that in the near future he will complete the trilogy by extending his historical studies to Malpighi, who, as an observer at any rate, is by far the greatest of these three heroic figures. It is true that Malpighi had the assistance of optical equipment not available to the other two, and although he frequently complained of its defects, he was nevertheless enabled to follow out the development of the heart and aortic arches in the chick with a success truly astonishing, and even unparalleled for more than a century after his time.

The plan of Adelmann's work includes the following chapters : life of Fabricius ; sketch of the history of embryology before Fabricius, illustrative of the relevant biological and philosophical environment of the story (necessary in assessing the value of Fabricius's own contributions and the interpretation to be put upon them); analysis of the two embryological works on the chick and the mammal, together with a bibliographical note ; translations of these two works, including ten leaves of explanatory matter accompanying a set of coloured plates in the library of the College of Physicians of Philadelphia (particularly important to most readers to whom the printed works only of Fabricius are available) ; facsimiles of the first editions of the printed versions ; notes and commentary ; literature consulted. There is also an excellent index. The one defect, or rather inconvenience, of this arrangement is the separation of the notes from the text. There are some 1,400 notes, which are not numbered consecutively but in thirty-two series, so that, for example, there are thirty-two notes bearing the number 1, and so on. Searching for the notes, which are much too important to be ignored, takes not a little time, the reader being continually switched over from one part of the work to another, and then back again, with the result that the continuity of the narrative is broken and its thread lost. Even if the harassed reader decides to read the notes separately, the drawbacks are scarcely less formidable.

A fascinating chapter of Adelmann's book is the vivid picture he draws of life in one of the most famous medical schools of Western Europe in the sixteenth century. From it we learn much of Fabricius as a teacher, of his evasions and irregularities, but we hear also of his successes, when he chose to exert himself. We owe to Fabricius, indeed, the earliest and most interesting anatomy theatre extant, now preserved as a national monument, which has been admirably described by Franklin. In this famous room, says Albinus, Fabricius was the first to dissect a human body before a great concourse of spectators. The students themselves were by no means a static factor in the situation. They exercised weighty authority in arranging courses of anatomy with their reluctant professor, nor did they hesitate to comment freely and openly on the result, whether satisfactory or otherwise.

Fabricius himself was more interested in research than in teaching. He was one of the first to emphasize the importance of the comparative approach to anatomical knowledge. His failures were due very largely to the influence of the scholastics, whom he could never bring himself completely to abandon. Nor must we forget that the vision of the pioneer cannot in the nature of things embrace the complete picture, no matter whether he is working in the sixteenth century or the twentieth. His mind is so obsessed with certain of the more obvious and attractive features of the problem under investigation that he neglects others of much greater significance. Not that he is necessarily unconscious of them, but that he fails to recognize their claim on his attention. Fabricius's own scheme of research was admirable, but in carrying it out he allowed Aristotle and Galen to play too large a part in it. If, however, the work of Fabricius is lacking in philosophical interest, it exercised an undoubted influence on the future of anatomical science, and especially on its comparative aspects. The "Fabrica" of Vesalius placed so heavy a premium on human anatomy that animal structure was in danger of neglect. It was left to Coiter, Fabricius and Casserius to restore the balance, not only by their own researches, but also by diverting the labours of others into the more profitable channel.

One anomalous and almost inscrutable feature in Fabricius's writings is that whereas he quotes liberally from his classical authorities, he often completely ignores the work of his contemporaries, even sometimes when it was carried out in his own department, and therefore must have been well known to him. For example, he claims to have seen the tensor tympani muscle in 1599, but Eustachius had

described and figured it in 1563, and the account of it published by Casserius in 1601 was contemporaneous with his own work, and the product of the school of anatomy in Padua. Again, Fabricius went badly astray on the structure of the auditory labyrinth, although the three osseous canals had been described by Fallopius in 1561, and his own pupil Casserius had discovered the membranous labyrinth of the pike in 1600. Such was the tangled mentality of the man which Prof. Adelmann has attempted, with conspicuous success, to unravel.

Fabricius's embryological researches were carried out on man, certain mammals (mostly ruminants), the grass snake, dogfish and the chick. In the chick he discovered the organ now known as the bursa Fabricii, and there are certain observations of value, but the plates are superficial and the general conclusions do not display much searching of the mind. In the mammal, however, he is much more successful, and this elaborate memoir must rank as the first treatise on *comparative* embryology. He was the first to figure and describe *accurately in detail* the cotyledonary placenta of ruminants, the peculiar bifid allantois of the sheep, the foramen ovale and the ductus arteriosus. Prof. Adelmann gives us a meticulously accurate English translation of these two memoirs, and the rendering of the many difficult passages shows that he is unwilling either to admit defeat or to hazard the long shot. We are also grateful to him for the facsimile reproductions, which for the purposes of work are as good as the originals, themselves difficult to obtain and then only at high prices. Prof. Adelmann's analytical commentary is a combination of fine scholarship, sound judgment, and a deep knowledge of the relevant modern research in the subject. It is only when all these conditions are satisfied that so important a book can be produced.

F. J. Cole.

A PHILOSOPHY OF FREEDOM

Religion, Science and Society in the Modern World
By A. D. Lindsay. (The Terry Lectures delivered at Yale University, 1943.) Pp. 64. (London: Oxford University Press, 1943.) 3*s*. 6*d*. net.

THE Terry Lectures at Yale in 1943 have been used not merely to discuss "Religion in the Light of Science and Philosophy", as the Foundation requires, but to do so in the midst of events affecting the Old World and the New to a degree never before experienced. It is such a setting which makes this nineteenth series perhaps more significant than any of its predecessors. Furthermore, Anglo-American relations are closer to-day than they were, and thus the choice of the Master of Balliol as lecturer was indeed a happy one. He recalls the historic connexion between his own College and the Franciscan movement, which stressed the acquisition of knowledge as an instrument of service. From this remark the main theme of these addresses can be discerned, namely, freedom in its connexion with religion, science and power. The strain of the Puritan can be picked up here and there; but the important thing is that the outlook so engendered is very far from negative, though perhaps scarcely everybody would subscribe to all the author's claims for it in the moulding of our traditional institutions. The pressure upon thought to issue in action would have delighted the late Prof. R. G. Collingwood, and may even be taken as yet another vindication of "Speculum Mentis". How easily, however, this urge may go adrift is seen from the fact that in our day a State has arisen wherein there is no place whatsoever for religion, science or philosophy. This is extremely suggestive: these blessings do not perish separately; they are submerged together.

The author notes in some detail our present-day assumption that science will go on indefinitely making discoveries, and adds very truly that in religion is first found the germ of the idea of infinite progress. What is not quite clear, however, is whether or not these two outlooks are trying to envisage the same thing. There is unquestionably a humanistic philosophy which looks forward—in brief—to 'bigger and better' everything. Conversely, nobody can seriously deny that all life on this world must ultimately become extinct, and that therefore the only valid progress is necessarily of a kind transcending purely mundane values. Certainly there is room in plenty for every kind of change and diversity in the meantime, but the massive doctrine of the degradation of energy still stands fast, keeping our eyes on the clock.

The impressive argument of these lectures is pleasantly interrupted for a moment or two here and there to let in something a little lighter. An example is the account of Hobbes becoming a sudden convert to geometry, upon meeting Euclid I, 47, for the first time. This experience happened in middle life, and apparently made him a 'mathematics fan', to continue unabated well beyond his ninetieth year. It is a pathetic little story, but nevertheless much to be wished that certain would-be enthusiasts of all ages and of all kinds would take note of it.

Returning to more serious things, Dr. Lindsay gives one of the best short descriptions of the Cartesian position as we now see it ever likely to be presented in a course of this nature, and goes on to declare "that the modern sciences for all their mathematics cannot do without perception and experiment and do not now want to do without them". Maybe; in fact very likely. But there are at least two most distinguished people, one at each of the ancient universities of Britain, who might rise up and set about this with no mean vigour, should they feel so disposed.

We are now constrained to see—in our day—an almost complete reversal of Descartes, who claimed a high degree of infallibility for science. Infallibility is admittedly not the same as all-sufficiency, but it will nevertheless be convenient to discuss here an important point which the Master of Balliol makes in his last lecture, on power and freedom. It is that one of the causes of our present distress is that students at our universities, on both sides of the Atlantic, have been encouraged to think of science as the be-all and end-all of human needs and affairs, whereas it is manifestly nothing of the sort. There are, we know, vast tracts of life's journey about which it can say nothing. As Prof. Koffka aptly says in his "Gestalt-Psychology", "Must we deny on week-days what we profess on Sundays?" In so far as the tendency exists, this urge to exaggerate the claims of science comes mainly from the smaller fry, very rarely from the great. Furthermore, it is a basic feature of any mature university system that the undergraduates go far to educate themselves rather than to be educated. Is it, therefore, not too much to ask that they show a modicum of mental independence and discernment? But a heavy responsibility rests upon authority to refrain from misleading, if ever, in fact, it is tempted to do so.

Some sixty years ago, the philosopher Dilthey approached this subject in a different way. He considered that whereas direct observation is the natural method for the physical sciences, the social group needs vital experience or a "living through" for its proper functioning. Dr. Lindsay adds that to starve ourselves of this re-creative imagination in an industrial age is to invite disaster.

Towards the end of the course comes much valuable meditation upon psychiatry and the interrelations between the healer and the healed. It is clear that this is a matter of the very greatest delicacy, far exceeding that of ordinary medical practice in curing bodily ills. The risks, obviously, are the gaining of power over the individual's life, and the twin evil of reducing people to neat preconceived psychological categories. The survival of human personality, in contradistinction to the rough-and-ready good of the race, needs constant vigilance. We have moved a long way from Arnold's Victorian view of the meaning of religion as "morality touched by emotion".

The Master of Balliol has deserved well of his audience—and now of his readers too—in unfolding before them what amounts in effect to a confession of faith. It may not be possible, or even desirable, to agree in detail with all that these lectures involve, but of their weight, charm and generosity there can be no doubt. F. IAN G. RAWLINS.

VITAMINS AND HORMONES

Vitamins and Hormones

Advances in Research and Applications. Edited by Prof. Robert S. Harris and Prof. Kenneth V. Thimann. Vol. 1. Pp. xvii+452. (New York: The Academic Press, Inc., 1943.) 6.50 dollars.

IN 1938 and 1939 the first two volumes of "Ergebnisse der Vitamin- und Hormonforschung" were published in Leipzig by the Akademische Verlagsgesellschaft M.B.H. It is not known whether further volumes were published, but none seems to have reached Great Britain. In 1943 the first volume of "Vitamins and Hormones: Advances in Research and Application" was published by the Academic Press, Inc., of New York. The format of the new publication, which is edited by Prof. R. S. Harris of the Massachusetts Institute of Technology and Prof. K. V. Thimann of Harvard, is highly reminiscent of that of the Leipzig publication. The scope and objects of the new publication also appear to be similar. This similarity is clearly not accidental, and suggests that "Vitamins and Hormones" has some kind of continuity with the German publication.

The format of "Vitamins and Hormones" leaves nothing to be desired, style, paper and print being excellent. One editorial improvement can, however, be suggested: I wish that the bibliographies, in which the references are numbered, were all in alphabetical order; in several instances the references are numbered in order of appearance in the text. The numbering of references permits of the omission of authors' names from the text, but it is good to note that for the most part this has not been done in the present volume of "Vitamins and Hormones". Admittedly, space is thereby saved, but the inclusion of authors' names adds greatly to the interest of the text and often gives the reader immediate valuable guidance as to the quality and orientation of the work in question.

Comparison of the subject-matter of the present volume with the second of the Leipzig "Ergebnisse" gives an interesting idea of the progress of the subjects in four years. In the 1939 volume there were eleven reviews, of which four were devoted to hormones or related substances. In the 1943 volume there are ten reviews, of which only two are endocrinological. The earlier reviews had a more general biological flavour; the later ones are concerned chiefly with specific physical, chemical or biological problems. The review by N. Jolliffe and R. M. Most, on "The Appraisal of Nutritional Status", is especially valuable at the present time, and the article by T. Reichstein and C. W. Shoppee, on "The Hormones of the Adrenal Cortex", makes most interesting reading in comparison with Reichstein's review covering similar ground in the 1938 volume. Another article in the present volume which attracts attention is by R. P. Hall, on "Growth Factors for Protozoa".

A hearty welcome should be given to "Vitamins and Hormones". The ever-increasing flood of original papers and the progressive specialization of knowledge is steadily adding to the value of authoritative surveys. Unfortunately, the organization of the writing and publication of reviews has largely grown up haphazard, and it may be suggested that serious attention should be given to the problem of organizing reviews in a manner appropriate to their importance. At present, such surveys fall roughly into two categories according to the breadth and depth of the subject-matter. On one hand, there is the kind which appears in the review journals and in the "Ergebnisse" and similar publications, and now in "Vitamins and Hormones". Such a review tends to present a general picture of relevant information on a small self-contained subject, perhaps emphasizing very recent work, but none the less presenting the survey in historical perspective and in due proportion. Many of these reviews are of the greatest value and, except on subjects showing very rapid growth, need be repeated on the same subject only at fairly infrequent intervals. The increase of knowledge is constantly making necessary the subdivision of subjects suitable for treatment in a review of this type. The second kind of review deals only with very recent work and can cover a wide field, but successive ones dealing with the same subject must be produced at short intervals of one, two, or three years. Many who have tried to write a review of this type will agree that it is most difficult to give a coherent, consecutive and accurate account of one or two years' work in a subject. The inevitable gaps and the absence of background make it impossible to fit the new observations into the general framework of the subject and lead to an appearance of extreme superficiality. When the subject chosen is too wide for discussion even of the very recent work, other difficulties arise. Recently I had occasion to pay considerable attention to a review of this kind. In twenty-five pages of text (about one thousand lines) there were references to nearly five hundred papers, that is, nearly one to every two lines. A review of this kind can be no more than a breathless catalogue giving, in most instances, no real indication of the results obtained, but merely hurried comments on what the author or the reviewer believes the results to show. This technique is to be regretted, since the results themselves are often of more permanent value than the interpretations currently placed on them, and are therefore the more worth emphasizing. A. S. PARKES.

WORLD STUDENT RELIEF

THE WORK OF INTERNATIONAL STUDENT SERVICE

By JAMES L. HENDERSON

British Committee, International Student Service

INTERNATIONAL STUDENT SERVICE dates from 1920, when European student relief was brought into being as an autonomous section of the World's Student Christian Federation to cope with the vast problems of student relief and rehabilitation in the university centres of Europe. In 1926, when the purely relief problem was less acute, and the need for a permanent organization on an international basis had come to be felt by many thousands of students, it was necessary to give European student relief a legal status in Swiss law. To this end International Student Service was formed, an autonomous body continuing the traditional work of student relief and cultural co-operation on a basis of entire impartiality in all matters of religion and politics, and thus encouraging the participation in the work of all men of goodwill, whatever their race, nationality or belief*.

In the period between the first and second world wars, International Student Service performed a two-fold function. It continued its various student relief activities and it also linked them to constant and searching inquiries into the real nature of a university and the place of the student in society. The problems of student self-help and co-operation were discussed at various international study conferences, and documents were collected concerning methods of selection of gifted students, student loan-funds, health services, hostel administration, and the place of foreign guest students in the national universities. It became a department of university research, which benefited from grants from the Rockefeller Foundation, and the Carnegie Endowment for Peace, published a series of studies on the trends of higher education in the various countries and inquired into the problems of academic overcrowding and unemployment in the learned professions, and academic freedom. Official recognition of the pioneer work of International Student Service in this field was given when the League's Committee on Intellectual Co-operation adopted the survey as a basis for its own work (Walter M. Kotschnig, "Unemployment in the Learned Professions", Oxford University Press, 1937).

In 1939 the coming need for renewed large-scale relief was evident. The World's Student Christian Federation and Pax Romana approached International Student Service, and an agreement was drawn up which, while leaving all three organizations in existence, founded a new organization in which they were combined. For this new organization the old name of European Student Relief was revived, and offices in Geneva were staffed by men and women who had worked for years with International Student Service, knew the various countries, and had the confidence of university people everywhere. Since the outbreak of the present War, student relief work has fallen into three main categories: student prisoners-of-war of all nationalities, student refugees and internees, and those students, particularly in Greece and Belgium, suffering from the extremes of malnutrition. So far as the much-needed relief work on the Continent is concerned, the British Committee of International Student Service works largely through its international headquarters in Geneva and is financially dependent on the support it receives from university men and women, graduate and undergraduate alike.

The past twelve months have seen a further aggravation of the university crisis in Europe, as well as in other parts of the world. Everywhere the impact of war has increasingly marked academic life, the very continuity of which is and will be threatened during the coming months.

In the occupied countries of Europe the struggle of the universities has reached its climax following the measures taken early in 1943 by the German authorities for the total mobilization of all man-power available on the Continent. These measures have not spared the students. In Belgium, in Holland, in Norway, labour service has been declared compulsory for them, those refusing to register being excluded from the university. In Holland things have gone a step further: following several incidents for which student groups were held responsible, each student was required to sign a declaration by which he pledged himself to undertake no action directed against the occupying power. Here, too, those refusing to sign were excluded from higher learning. In France, the entire younger university generation has been mobilized for work in Germany, this measure being carried out by the French Government itself. Events in Norway are too vivid and recent to need further comment.

In all these countries, which have furthermore been afflicted by hard material privations, the students have made a brave stand. Few have yielded without resistance. In many universities strikes and other manifestations have taken place, expressing the opposition against the measures which have been imposed. Hundreds of students have even preferred to abandon their universities, to hide in their own country, or even fly abroad, with all the risks entailed, rather than be engaged against their will in the war machinery.

In belligerent countries also the situation of the universities has deteriorated during recent months. Not only has the number of students been drastically reduced, following mobilization from the age of eighteen or even seventeen; not only have many courses been shortened, with the object of adapting the curriculum to the war emergency; but also the very existence of the universities, as independent institutions devoted to the search for truth, has been questioned in some official quarters. In both belligerent parties voices have been heard which expressed the wish that for the duration of the War the universities should limit their aim to providing the State with an adequate number of technicians and young scientific workers required for the conduct of the War. Fortunately, however, this attitude has not been generally accepted, and leading university people have expressed themselves against a tendency which has found an expression in the emphasis laid everywhere on courses in natural and technical sciences as against arts and law. But the fundamental trend remains, and it is certain that, while the War will progressively drain all resources and energies in the belligerent countries, it will reduce the area in which cultural life will be able to develop with the freedom required.

While the universities in belligerent, as well as in occupied, countries have lost the greatest part of the younger generation who, in normal circumstances,

* International Student Service (British Committee), 11D (Lower) Regent Street, London, S.W.1.

would have filled their class-rooms, the number has increased again of the students who, cut off from their Alma Mater and forced for one reason or another to interrupt the course of their higher education, have faced alone and prematurely the gruesome hardships of the world at war; student refugees, for whom the summer months of 1943 brought new agony and who in hundreds had to fly from countries where they were threatened with arrest and deportation; students under the occupation, constantly in danger and weakened by months of nervous strain; student prisoners worn out by more than three years behind barbed wire; thousands and thousands of young men and girls who, in soul and body, have desperately suffered during the past year as a consequence of the present tragedy.

This development in Europe could not be watched passively by the European Student Relief Fund without an attempt being made to expand the work to some, at least, of the areas where the need was deepest and where, up to this date, conditions have prevented the organization of student relief.

Educational help to war prisoners and individual relief to internees or refugees in countries such as Switzerland and southern France—still under Vichy rule—was no more enough. Hunger was the major problem of thousands of students in occupied countries; an attempt to help them had to be made.

The delicate questions of principle connected with this broadening of the European Student Relief Fund programme were discussed by its executive on a concrete issue when, in the spring of 1942, an appeal was received through the International Red Cross for the students in Greece. At first the members of the executive felt uncertain whether a positive reply should be given to this call. The fear was expressed that the fact of the European Student Relief Fund engaging in a food relief scheme, in an occupied country, would create difficulties for its Anglo-Saxon friends, and perhaps make it impossible for them to obtain any longer the licences required for transmitting their funds to Geneva. However, after a full discussion, the executive finally agreed that the European Student Relief Fund should be ready to take its share in relieving the material needs of the student, as well as the intellectual ones. In order to prevent this decision from creating any difficulty for the committees in Allied countries, the following lines of policy were adopted:

(a) For all questions concerning relief in Greece, the European Student Relief Fund would use the channel of the Joint Relief Commission of the International Red Cross, the agency recognized by all Governments for the administration of relief in occupied countries, and which can guarantee, through its delegates on the spot, the rapid and impartial distribution of the resources made available.

(b) For the financing of food relief projects, only funds raised in neutral countries such as Switzerland, Sweden or Portugal, would be used, the resources received from the Anglo-Saxon countries being restricted to the financing of the work among prisoners of war, and in unoccupied countries. At the same time, the Committees in England and the United States should be invited to take part in the expanded programme in so far as they would be able to obtain, through the suitable agencies, the transfer licences required.

Along these lines the European Student Relief Fund has developed, since the summer of 1942, an increasing activity among students in Greece and other countries affected by famine. In some instances, even the Committees in Anglo-Saxon countries have been able to make special contributions for these projects. Thus the decision taken was justified by events.

Adapting itself to the aggravated situation, the European Student Relief Fund pushed ahead energetically with an enlarged programme. Fighting against hunger and despair became the slogan under which Geneva faced its increased responsibility through the fourth year of the War.

The plight of the student groups with which the Fund is related in Europe has been equalled in other parts of the world. There are the students of the U.S.S.R., whose country has been invaded, whose institutions of higher learning have been destroyed (see NATURE of January 8, p. 49). Under the pressure of the invading forces, they have had to withdraw into the depths of their immense country. There, in the central provinces of the U.S.S.R., universities and schools have resumed their work. But conditions are precarious; the students have, in many cases, lost all their belongings; they are cut off from their families; they lack the primary necessities of life. Their need is great.

This development can be compared to the striking events which, since 1937, have taken place in China. Here, too, many universities which were situated in the coastal areas have been transferred to the interior, in regions scarcely touched by civilization. The Chinese Government and the university communities concerned, through the efforts of which this transfer has been rendered possible, have thus given splendid evidence of their faith in the value of higher learning as the foundation of a national culture. Through the six years of their gallant struggle, the Chinese students have been greatly encouraged by the uninterrupted help which they have received through the agency of International Student Service and the World Student Service Fund in New York. This help has been continued during recent months, and the students of China have become increasingly aware of the fact that their fight is the fight of all students in the world, united by a common creed of the value of truth, objectively searched for and passionately desired.

Thus the trend already visible last year towards the unification of relief efforts in the various parts of the world has been reinforced. It is no longer possible to draw a strict line between the activities in and outside the realm of the European Student Relief Fund competence. The continental frame set up three years ago has been broken by the reality of war. There is one single world conflict. Only a united world relief administration will be able to cope adequately with the needs arising everywhere.

World Student Relief is now formally constituted. Its work will be conducted in the same spirit as that of the European Student Relief Fund, and its administration will likewise be entrusted to International Student Service. The headquarters of World Student Relief will be in Geneva, where the main executive, on which the member organizations will be adequately represented, will meet. In Europe the work will be continued under the auspices of the European Student Relief Fund. Two affiliated Committees are in process of formation: the first, in New York, which will be competent to handle relief problems on the American continent, in the Far East, and provisionally in the U.S.S.R., with which contact is impossible from Geneva; the second, in London, with the special responsibilities of organizing relief within the British Commonwealth, and of

co-operating with the New York Committee in the conduct of the Chinese action.

This arrangement should enable the groups concerned with student work to cover efficiently all five continents, provision being made for ensuring the continued development of relief activities in case one of the regional centres should be paralysed following an unexpected turn in the War. Thus, an organization now exists which is well equipped for serving the cause of student solidarity, in the East as in the West, during and after the War.

NATIONAL FLOUR AND BREAD

FOURTH REPORT

From the Scientific Adviser's Division, Ministry of Food

THE present report is a continuation of the work described in the previous three reports[1] on flour and bread in Britain, and deals with 440 samples of breadmaking flour and 1,408 loaves received in the period May 8–December 31, 1943.

Quality of Flour

The quality of British-grown wheat used in the grist depends upon the stock position, but it is now generally high, as the following table shows. For the bulk of the year 10 per cent of diluents (mainly barley, but also rye and oats) were also added.

BREADMAKING GRISTS IN ENGLAND AND WALES

Period	Home Grown Wheat (min. proportions)	Diluents (fixed proportion)	Imported White Flour (fixed proportion)
From 1. 1.43	35–45 per cent	5 per cent	5 per cent
25. 1.43	35–45	10	5
7. 2.43	35–45	10	5
19. 4.43	40–45	10	5
14. 6.43	30–40	10	5
21. 6.43	20–30	10	5
28. 6.43	20	10	5
6. 7.43	Optional, according to supplies available	10	5
23. 8.43	Some areas 25 per cent Others optional	10	5
30 8.43	20–35	10	5
13. 9.43	30–40	10	5
27. 9.43	45–50	10	5
4 10.43	50	10	From 24.10.43:7½
22.11.43	52½	7½	7½
6.12.43	55	5	From 12.12 43.10
20.12.43	57½	2½	10

In the earlier months of the year, most of the flour used in Great Britain was enriched with calcium carbonate at the rate of 7 oz. per sack of 280 lb. (0·16 per cent), and, in fact, by August 1, *all* the mills in the country had the necessary equipment to make this addition, which is now general.

Fibre and Vitamin B_1. The following table shows the different levels over the 440 samples. A correction has been made in the fibre figures to allow for the small percentage of added Canadian G.R. flour (white flour fortified with vitamin B_1 to about the same level of National flour).

The 'national average' figures for fibre and vitamin B_1 in the period under review were 0·55 per cent and 1·0 I.U./gm., or practically identical with the figures for the previous period, October–May 8, 1943 (cf. Third Report).

Protein Content. This depends on the percentages of Manitoba and English wheats, for which the average protein contents are about 14·0 and 9·4 per cent respectively. The protein contents of the samples received during each of the five months August–December averaged 12·25, 12·1, 11·1, 11·1 and 11·0 respectively.

Fibre		Vitamin B_1	
Value (per cent)	Samples (per cent)	I.U /gm.	Samples (per cent)
0 4 and less	4 6	1 20 and more	2 3
0·4 ,, ,,	31·6	1 10 ,, ,,	10 7
0 55 ,, ,,	52 6	1 05 ,, ,,	22·0
0·6 ,, ,,	67·0	1·00 ,, ,,	49·0
0·7 ,, ,,	87·2	0·90 ,, ,,	83·5
0·8 ,, ,,	94·7	0 80 ,, ,,	98 0
0 9 ,, ,,	97 2		

Granularity. The size of the bran particles continues to diminish, and 420 samples examined (after correcting for the added white flour) gave the following results:

Total over 5 silk (aperture 0·27 mm.)	Total over 8 silk (aperture 0·19 mm.)
1·5 per cent	5·4 per cent

Calcium Carbonate Content. One half-pound sample of flour from each mill is examined weekly to test the uniformity of the calcium carbonate additions[2,3]. The following table shows the results of these analyses for the month of November:

Calcium carbonate (oz /sack)	Corresponding capacity of mills (sacks/hour)	Percentage of total sack capacity examined
4·5 and less	238	4 4
4·6–5 5	448	8 1
5·6–6·4	1,156	20·9
6·5–7·5	2,599	47·0
7·6–8·5	745	13·5
8·6–9 5	290	5 2
9 6 and over	56	1·0

No. of samples tested = 1,310.

The calcium carbonate for the flour as a whole will be 7 oz. almost exactly; but there will be slight departures from this figure up and down the sack, depending upon the accuracy of feeding the calcium carbonate. Creta præparata is one of the most difficult products to feed because of its poor flowing properties, and the above table illustrates the range of variation due to this cause.

Quality of Bread

The following is a summary of the 1,408 loaves examined:

Quality	No. of loaves	Percentage
Good	297	21
Fair-Good	418	30
Fair	477	34
Poor	216	15

The lower general level of quality is due mainly to the high percentage of English wheat and the presence of diluent grains with grist. At the same time, it is of interest to note that all samples of flour received for analysis are also tested for baking quality under standard conditions. The 440 samples of flour gave the following results[4]:

Quality	No. of loaves	Percentage
Good	194	44
Fair-Good	115	26
Fair	100	23
Poor	31	7

The above results show that approximately 70 per cent of the loaves baked in the laboratory were

graded good or fair–good, whereas the corresponding figure for the commercial loaves was 51 per cent. This difference is a rough measure of the lower average result obtained in commercial as against laboratory production.

The following factors should be borne in mind, however : (*a*) The commercial bread had been posted from different parts of the country before examination. (*b*) The laboratory loaves were baked under controlled conditions of water absorption, fermentation and temperature. Such conditions are not always possible in commercial practice. (*c*) Particular loaves may have characteristics to suit local tastes, for example, thick crust, which may be regarded as faults in examination.

It is clear, therefore, that considering present conditions and the nature of the grist, the quality of much commercial bread is surprisingly good.

The faults in the commercial loaves were due to a number of factors, chief of which was incorrect fermentation of the dough ; but there was also evidence of wrong water absorption, poor manipulation and insufficient baking.

The work of this report was carried out at the Cereals Research Station of the Ministry of Food, St. Albans.

[1] NATURE, **149**, 460 (1942) ; **150**, 538 (1942) ; **151**, 629 (1943).
[2] Greer, E. N., Mounfield, J. D., and Pringle, W. J. S., *Analyst*, **67**, No. 800, 352 (1942).
[3] Greer, E. N., and Dawson, E. C., *Analyst*, **69**, No. 814, 141 (1944).

A NEW FORM OF MICROFILM READER

By DR. E. H. J. SCHUSTER

MICROFILM readers are divided primarily into two classes : in one, the magnified image of the film is projected on to a ground-glass screen from behind and is viewed as a transparency ; in the other, the image is thrown downwards on to an opaque screen. The first lends itself to the construction of a neater and more compact type of apparatus, but the second was thought to show a better defined image and one more pleasant to read. It was therefore chosen for an instrument designed for the Library of the National Institute for Medical Research. This consists of an open-fronted box, of which the bottom forms a reading desk and the top supports the projector. The sides are attached to a horizontal base-board ; they extend below the reading desk and are so shaped that the latter makes an angle of 20° with the horizontal, and the back slopes forward at the same angle to the vertical ; the angle of slope of the front edges of the sides is slightly less.

The Projector is an independent unit consisting of a 'Bakelite' platform on the upper surface of which are mounted the following components : (1) The lamp (a Kodak miniature projection lamp, 100 volts, 100 watts) in its housing. (2) The condensing lenses. (3) The pressure plates. One of these is fixed to the lens holder and the other is held in guides which allow it a limited movement backwards and forwards. Normally it is held against the fixed plate by springs at either end, but two small electromagnets, one mounted near each spring, when energized can overcome the resistance of the springs and separate the plates, giving a free passage for the film. (4) The lens holder, which as just stated carries the fixed-pressure plate at one end ; at the other is a focusing mount for the lens. The lens is of 2-in. focus and $f/3$ aperture. (5) The prism. The vertical face of this is as near as possible to the front of the lens, the oblique face is silvered and the centre of the horizontal face coincides with the axis of rotation of the projector platform. (6) The spool spindles. Mounted below the platform are its locating tube and the spool-spindle gearing. The locating tube is attached at right angles to the platform immediately below the prism ; a hole is cut in the platform concentric with it. The tube is about $2\frac{1}{8}$ in. in internal diameter and $2\frac{1}{2}$ in. long ; it slides into a cylindrical bearing which passes at right angles through the top of the box. The whole projector can be swung about this bearing through any angle, so that a page, however situated on the film, can be viewed with its top upwards. There is enough friction to maintain the projector firmly in any position. The outer circumference of the cylindrical bearing forms a journal for a ring gear, through which motion is transmitted from the control unit to the spool gearing.

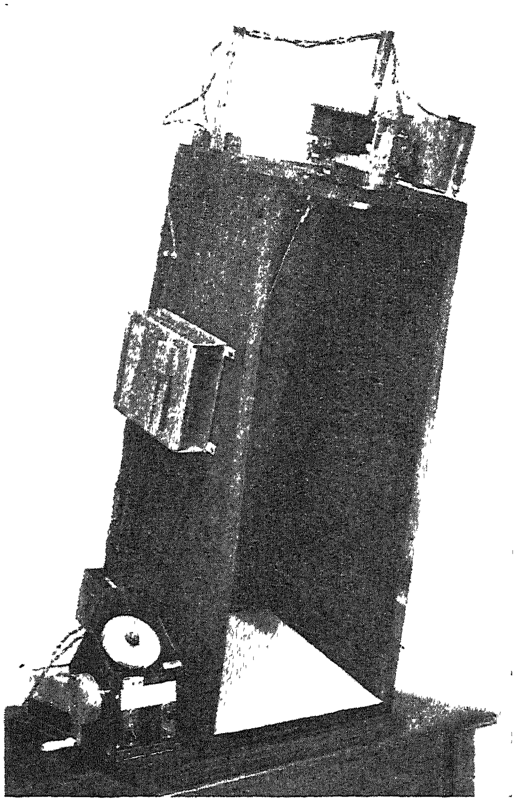


FIG. 1. MICROFILM READER AT THE NATIONAL INSTITUTE OF MEDICAL RESEARCH.

The Control Unit is attached to the left hand of the base board near the front, with its handle conveniently placed for operation by the left hand of the user. By this handle the film can be moved backwards or forwards, and it is so constructed that before the film can be moved the pressure plates must be separated.

Automatic Control of the Pressure Plates. This is effected in the following way : the handle has inner and outer concentric cylindrical portions ; the former is rigidly attached to the horizontal shaft of the control unit and the latter to a rod which passes centrally through the shaft and engages with the

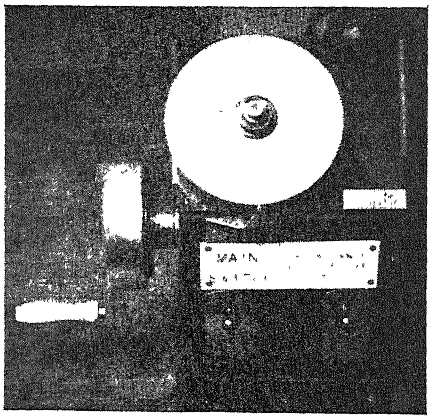


FIG. 2. CONTROL UNIT.

spring-loaded moving arm of an electrical key at its far end. When the handle is not in use, three equally spaced rollers with radial axes carried inside the outer handle cylinder rest at the bottom of three V-shaped grooves cut in the free edge of the inner handle cylinder. When the handle is turned, at first only the outer portion moves; the rollers ride up on one side or the other of their grooves, and this imparts a short axial movement to the outer handle, which causes the central rod to pull the moving arm of the key into contact with the fixed arm; an electric circuit is thus closed which energizes the magnets separating the pressure plates. When contact is made, further movement of the outer handle is stopped and the whole handle and the horizontal shaft turn as one piece. When the handle is no longer being turned, contact is broken by the spring, which at the same time pulls the rollers back to the bottoms of their grooves. A trickle charger supplies low-tension rectified current for the magnets.

Movement of the Film. Rotation of the handle is transmitted to the spools in the following way. On the horizontal shaft is mounted a spiral gear wheel which meshes with a similar wheel on a short vertical shaft in the control unit. A rod provided at each end with a universal joint is attached below to the vertical shaft just referred to, and, passing through a slot in the left side of the box, is attached above to another short vertical shaft. This passes through a bearing in the top of the box and carries above a spur wheel meshing with the lower edge of the ring gear; the upper edge of the latter engages with intermediate wheels, which in turn mesh with the spool-spindle gears.

The two spools may be differentiated as the fixed spool and the loose spool; the former is an integral part of the apparatus and the latter belongs to the particular film being read. The spindles carrying both pass through bushes in the projector platform and carry the spindle gears referred to above on their lower ends. The nature of the motion transmitted to the spindle gears is different in the two cases. When all gears are in mesh one revolution of the handle in either direction causes one revolution of the fixed spool in the corresponding direction, but the amount of rotation of the loose spool varies, being just that which is necessary to give off what film is being taken up by the fixed spool or to take up what is given off by it; this, of course, alters with the angle through which the fixed spool has been turned and with its diameter as affected by the amount of film wound on to it. When the fixed spool is full and the loose spool is empty, the latter will have to turn three times as fast as the former. The construction which enables the loose spool spindle to function correctly is as follows: its gearing is such that one turn of the control handle can cause three turns of the spindle, but by the interposition of a ratchet the turns will only be in the direction which will enable the loose spool to take up the film given off by the fixed spool; the giving off of film is permitted by the spindle slipping in the sleeve by which it is attached to its gearing. The correct degree of friction between the two is maintained by a spring-loaded felt washer. Slipping also occurs when the loose spool is taking up film, its degree varying with the relative amounts of film wound on the two spools.

The intermediate gears between the ring gear and the spool gears are mounted on swinging brackets; thus either spool can be thrown out of gear. It is convenient to use this device when inserting a film as it enables both spools to be turned as required by hand, and when rotating the projector. When rewinding a film on to the loose spool it saves a good deal of time and physical effort to throw the fixed spool out of gear; the loose spool then takes its time from its own gearing and a three-to-one increase of speed is obtained.

Indexing. As the films used in a library may be long enough to contain 800 pages of a book or more, it is of some importance to be able to wind straight to a point as near as possible to the page needed, without having to keep stopping the film to see where one has gone. If the tightness of winding does not vary very much, then whenever the film is used, any page on it will come into view each time after approximately the same number of degrees of rotation of the spool, or, which amounts to the same thing, of the handle. All that is required, then, is a measure of the rotation of the handle and the indexing of each film in relation to it. The first is provided by the control unit; its horizontal shaft carries a fine-pitch worm; this drives a wheel with a large number of teeth mounted on a shaft which passes through a bush in the front panel of the control unit. A dial graduated according to an arbitrary scale is mounted on the shaft where it emerges from the bush, being held friction-tight by a spring washer against a flange. Any division on the scale can thus be set by hand to a fixed reference point; but the friction is great enough to ensure that the dial will otherwise always turn with the shaft. The face of the dial is tilted upwards so as to be easily read by the user.

The index should be made when the film is first delivered to the library. The indexer turns the film to the first reference to be entered and then sets the dial to zero. Then as he works through the film he notes the dial reading at which each other reference appears. A table of contents 'paged' according to the scale on the dial thus results, from which such alphabetical indexes as may be required can be derived. Where the film is of a continuously paged book, a concordance between the dial readings and the page numbers of the book may be used in conjunction with the index of the book itself. As it would be very inconvenient to turn to the index in the film, it must be consulted from a copy, possibly abbreviated.

It may well be found convenient in libraries to store short lengths of film by sticking them together into long continuous rolls; the identification number of the roll together with the dial reading recorded

in a card index would enable any item to be found quickly.

Acknowledgments. The optical system used in the instrument described was designed by Mr. J. Smiles, of the National Institute for Medical Research, and he also selected the components. I have to thank Mrs. Moholy, director of the Microfilm Service of the Association of Special Libraries and Information Bureaux, for much valuable information and help.

'MAGNETIC' CURRENT

By JAMES T. KENDALL

Research Department, Metropolitan-Vickers Electrical Co., Ltd.

THE account of Ehrenhaft's claim to have discovered a magnetic current, which appeared in the daily Press of January 17, is very brief and possibly inexact. However, it appeared to be so completely contrary to the fundamental conceptions of electricity and magnetism, that thoughtful readers must search their minds for other interpretations of the experimental phenomena he is reported to have observed. Accordingly we at once set up apparatus to repeat the experiments which the Press had described.

The soft iron pole-pieces of a powerful electromagnet were immersed in dilute hydrochloric acid. A fine stream of bubbles was given off at each pole, and when the magnetizing current was switched on, the streams of bubbles tended to be deflected into the space between the poles, which was 1·5 mm. wide. Some of the bubbles were deflected downwards, against their buoyancy. Close observation showed that the motion of the bubbles was apparently caused by the motion of the liquid as a whole. Small inequalities of concentration, which are shown up as refractive index striations, permit any motion of the liquid to be recognized. Under the influence of the magnetic field, a steady streaming of the liquid from the pole faces into the centre of the gap and the consequent setting up of rotary currents in the liquid were observed. The streams of bubbles were entrained and carried along with this movement, and their motion was mainly controlled by it.

Confirmation of this motion of the liquid was obtained by repeating the experiment with the pole-pieces covered with a film of paraffin wax, and immersed in a solution of ferrous chloride. Under these conditions no bubbles were formed and no movement of the liquid in the magnetic field took place. However, if water was slowly poured into the solution, thus providing a non-uniform concentration of ferrous chloride, movement of the liquid in the magnetic field did occur. If the addition of water was stopped, the motion gradually died away as the concentration of ferrous chloride regained uniformity.

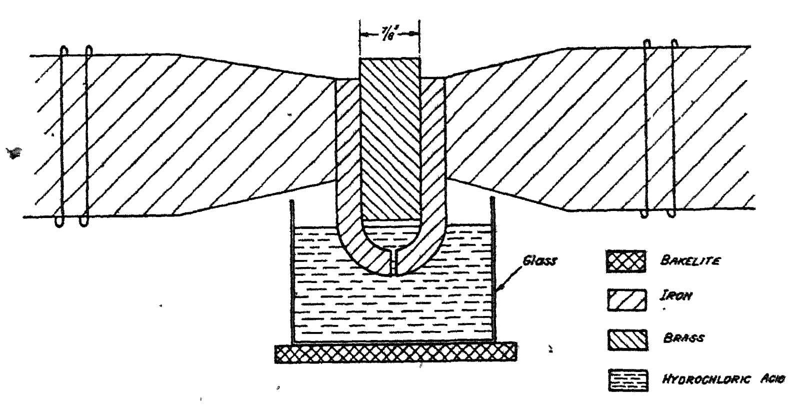
The movement of the liquid under the conditions above described can be explained very easily. It is due to the action of the strong, non-uniform magnetic field on the non-uniform concentration of paramagnetic ferrous ions. The parts of the liquid containing a high concentration of ferrous ions will tend to move into the strongest parts of the field. In confirmation of this, a number of other electrolytes were tried, both with waxed and unwaxed pole-pieces. No movement was observed with potassium chloride or cadmium sulphate under any conditions. Movement was observed with ferrous sulphate, ferric chloride and nickel sulphate under conditions of non-uniform concentration.

These experiments demonstrate conclusively that the general movement of the liquid, disclosed by refractive index striations, depends essentially on the presence of ferrous or other ions of high magnetic susceptibility. We wished to be sure that the movement of the bubbles formed at the unprotected iron pole-pieces was also due to the movement of the liquid, caused by the presence of the ferrous ions, which are provided by the solution of the pole-pieces in the acid. Accordingly the pole-pieces were heavily plated with cadmium and were then immersed in dilute hydrochloric acid. Bubbles of gas were liberated as before, but their motion in the liquid was entirely unaffected by the magnetic field: it was impossible to tell from their motion whether the magnetizing current was switched on or not.

In addition to the motion of the bubbles in the magnetic field, Ehrenhaft is also reported to have claimed that oxygen is evolved at the north pole and hydrogen at the south pole. Accordingly we immersed the bare iron pole-pieces in dilute hydrochloric acid and collected the gas from each pole separately. To facilitate this, a thin strip of mica was placed between the poles. The oxygen content of the gas was determined by heating a platinum filament to redness in it. A slight contraction in volume took place, corresponding to 0·54 and 0·49 per cent of oxygen in the gas from the north and south poles respectively. The probable error in analysis was $\pm$ 0·03 per cent of oxygen. This small percentage of oxygen was expected, since during the course of the experiment the pole-pieces became warm (due to the current in the magnetizing coils) and air dissolved in the acid would then be evolved. It would seem to be rather difficult to prevent the presence of a little oxygen (due to this cause) in the collected gas, and perhaps Ehrenhaft's reported observation may be accounted for in this way.

A third reported observation—that the pole strength of a permanent magnet decreases when immersed in dilute acid—we have not attempted to confirm. If sufficient of the permanent magnet were dissolved away, there would, of course, be a measurable decrease in its pole strength.

Our interpretation of the experiments we have made here may



EXPERIMENTAL ARRANGEMENT OF THE ELECTROMAGNET.

perhaps explain the effects attributed in the Press to Ehrenhaft. These may turn out to be no more valid than his previous claims of the existence of charges smaller than the electron (see *Phys. Z.*, 21, 675, 683; 1920). However, we must reserve final judgment until a fuller account of his experiments is available.

Apart from the failure here to confirm some of Ehrenhaft's reported effects, the observation of the movement of the liquid caused by paramagnetic ions in the magnetic field is of some interest. It may possibly form the basis of a method for separating the rare earth elements, the aqueous solutions of which differ markedly in magnetic susceptibility. The modern method of separating gaseous isotopes by thermal diffusion might be paralleled by a method of separating aqueous rare earth ions by 'magnetic diffusion'.

The accompanying diagram, drawn to scale, shows the arrangement of the magnet and soft iron pole-pieces: it should be noted that they are soldered to a brass block. This forms an important feature of the apparatus, and was provided to ensure that the experiments could not be vitiated by the passage of unsuspected leakage currents through the liquid. The average magnetic field between the pole-pieces was measured and found to be 11,000 gauss.

OBITUARIES

Prof. Pieter Zeeman, For.Mem.R.S.

PIETER ZEEMAN was born, the son of a clergyman, at Zonnemaire, Holland, on May 25, 1865. In 1885 he went to Leyden, where he became a pupil of H. A. Lorentz and Kamerlingh Onnes, and took his doctor's degree in 1893 with a thesis on measurements of Kerr's magneto-optical phenomenon. He held various positions in the physics department of the University of Leyden between 1890 and about 1900. In that year he was appointed professor of physics in the University of Amsterdam, where he spent the rest of his life.

It was while he was at Leyden, in 1896, that he discovered the effect since known by his name. In a nutshell, this is the fact, hitherto unknown, that the quality (frequency) of light is changed if the light is generated in a magnetic field. This implied an immediate connexion between two great branches of physical knowledge, light and magnetism, previously almost without contact. The mathematical expression of the fundamental effect in its simplest form is $\Delta\nu/H = \frac{1}{2}\, e/mc$, where $\Delta\nu$ is the change in frequency of the radiation, H the strength of the magnetic field, c the velocity of light *in vacuo*, and e and m the charge and mass of the emitting particle. Thus the change of frequency per unit field multiplied by twice the universal constant c is equal simply to the ratio of the charge to the mass of the emitting particles. This result, together with others of interest about the polarization and other details of the radiation, was deduced in 1897 by Lorentz as an inevitable consequence of the assumption that the emission of light was caused by the motion of electrified particles in an electro-magnetic field. While this statement would have been hotly contested in 1896, it is difficult to appreciate now that there was then any reasonable alternative short of the miraculous creation of light.

These considerations—and they could well be amplified—suffice to establish the basic importance of Zeeman's discovery; but in other respects also it was one of the most remarkable discoveries in the history of physics. Historically, it claimed immediate attention as a conspicuous success where Faraday had been baffled half a century earlier. The epoch of its origin was singularly auspicious. In 1897, measurements of e/m for the carriers of the cathode rays by the magnetic deflexion method were published by J. J. Thomson in England and by Wiechert in Germany. Their results were identical within the experimental error with the value found by Zeeman for the particles emitting spectral lines. But all these values were 1,850 times as great as the value of e/m for the lightest charged particle, the hydrogen ion, recognized by electrochemistry. If electricity was essentially atomic, a conclusion almost forced by Faraday's laws of electrolysis, we were here dealing with an apparently ubiquitous particle having a mass m much less than that of the smallest accepted particle, the hydrogen atom. This was settled soon afterwards by direct measurements of e by J. J. Thomson, confirmed by Planck's calculation from the intensity of heat radiation, which showed that their charge was indeed the same as the charge on the hydrogen ion. Thus was the electron born.

Another remarkable, and also perhaps fortunate, circumstance attending Zeeman's great discovery was that it was made at a time when the experimental technique was good enough to reveal the essential foundations, but not good enough to disclose the complicated structures which subsequent technical refinements brought out. Had the discoverer been confronted with all this at the outset, he might have despaired of ever making any sense of it. However, these developments, in which Zeeman himself played a notable part, have proved very important in several directions, and particularly helpful in clarifying and extending the quantum theory.

The Nobel Prizes, which are awarded annually, commenced in 1901. In that year the prize for physics went to Roentgen for his discovery of X-rays. In 1902 this prize was divided between Lorentz and Zeeman for researches on the influence of magnetism on the phenomena of radiation. This is another illustration of the timeliness of the discovery and of the prompt appreciation of its importance.

Zeeman's was a life devoted to increasing and improving our knowledge and understanding of physical phenomena by experimental methods. Much of it was in the field of magneto-optics, in which he was successful so early, and the greater part of it has had some optical connexion. This is not the place to review this in detail, but there is one thing that must be said. It is all characterized by extreme thoroughness and bears the hall-mark of the master of the art of experimental discovery.

Zeeman was elected a foreign member of the Royal Society in 1921 and an honorary fellow of the Physical Society in 1929. He was also a foreign or corresponding member of many other of the world's learned societies and academies. His achievements were recognized by the Dutch Government in creating him a Knight of the Order of the Netherlands Lion and a Commander of the Order of Orange Nassau.

His seventieth birthday, May 25, 1935, was celebrated by the publication in his honour of a volume comprising fifty original papers contributed by friends and admirers representative of the world's leading physicists.

Zeeman had a quiet and peaceful disposition, but he was by no means unforceful. His manner and temperament inspired immediate confidence. He was

very genial and likable, and his loss will be mourned by many sincere friends. He died on October 9, 1943, after a short illness and is buried in the Kleverlaan Cemetery at Haarlem. He was a worthy member of that company of great men who have made Holland, despite its handicap of size and population, stand out among the nations in the history of scientific achievement.

OWEN W. RICHARDSON.

Mr. Edward A. Martin

MR. E. A. MARTIN died at the age of seventy-nine on December 14 at Brighton, where his father had been mayor before him. Mr. Martin was well known as a lecturer on geological subjects, some of which he published in book form. His "Sussex Geology and other Essays" (Archer and Co., London, 1932) includes a chapter on "Clayton Windmills and the Dew-Ponds", among which is mentioned the windmill illustrated in NATURE of February 27, 1932, from the great Chinese Encyclopedia of 750 volumes in the eighteenth century. His researches on dew-ponds appeared in papers for the British Association and Royal Geographical Society. Other essays appeared in the *South-Eastern Naturalist*, of which he was honorary editor from 1916 until 1924.

Mr. Martin was honorary general secretary of the South-Eastern Union of Scientific Societies during 1924–35. To readers of NATURE he will be best remembered as the author, under the initials E. A. M., of the annual reports of Congresses of the South-Eastern Union, many of which he organized personally as well as contributing papers. He edited a bibliography of Gilbert White's writings for the Selborne Society; the geology side of *Knowledge* and the *Journal of the Commons, Open Spaces and Footpaths Society*. He was actively associated with the Croydon Public Library, and while residing in that borough, served during the War of 1914–18 as a commander of the Metropolitan Special Constabulary. On resigning the secretaryship of the South-Eastern Union he became a vice-president of the Union. He retired to Brighton in 1935.

In 1887 Mr. Martin married a daughter of H. T. Carpenter, a Common Councillor of London and then a ward in Chancery. His widow and three children survive and a nephew, Henry Martin, is editor-in-chief of the London Press Association.

T. DANNREUTHER.

WE regret to announce the following deaths:

Major H. J. L. Beadnell, formerly of the Egyptian Geological Survey, on January 2, aged sixty-nine.

Dr. F. D. Chattaway, F.R.S., fellow of Queen's College, Oxford, and formerly a distinguished chemist, on January 26, aged eighty-three.

Sir John Bretland Farmer, F.R.S., emeritus professor of botany in the Imperial College of Science and Technology, on January 26, aged seventy-eight.

Dr. C. B. Kingston, president in 1938–39 of the Institution of Mining and Metallurgy, aged seventy-six.

Dr. H. A. Mess, reader in sociology in the University of London, on January 23, aged fifty-nine.

The Rev. Sir John O'Connell, vice-president of the Statistical and Social Enquiry Society of Ireland, on December 28, aged seventy-five.

Sir Kynaston Studd, Bart., O.B.E., president and honorary chairman of the Polytechnic, London, on January 14, aged eighty-five.

Sir Thomas Ward, C.I.E., M.V.O., formerly inspector-general of irrigation in India, on January 27, aged eighty.

NEWS and VIEWS

Functional Collaboration in Colonial Territories

IN the House of Lords on January 26, Lord Listowel asked what action is being taken by the Government to prepare for the organization of security, development and welfare services throughout the British Empire on a regional basis. Lord Cranborne, Secretary of State for Dominion Affairs, replied on behalf of the Government. He said that, while contentious constitutional questions should be put aside for the time being, they must be continually borne in mind. So far as regional international machinery is concerned, the idea is still sufficiently novel to arouse suspicion. Nevertheless, our limited experience of such collaboration in commissions composed of representatives of nations with colonial possessions in the areas concerned has been encouraging. This scheme of constructing machinery to link up certain territories for purposes where common action is desirable has for some time been used in the British Empire as, for example, in the East African Governors' Conference, and regional grouping in the West African Colonies. An example of its extension on an international scale is provided by the Anglo-Caribbean Commission, the working of which has been very satisfactory. The essential point in considering such functional collaboration of neighbouring territories is the realization that it involves joint control, but not joint government. Referring particularly to the recent conference between Australia and New Zealand adumbrating a scheme for such an organization for the South Pacific, Lord Cranborne said that the Government welcomes this movement, and would also welcome the establishment of machinery of a collaborative and consultative nature in other areas in which various nations with colonial interests are concerned.

European Relief during 1919-20

THE Economic, Financial and Transit Department of the League of Nations, under the title "Europe's Overseas Needs 1919–20 and How they were Met", has issued an account of the failure to face the problem of Europe's post-war requirements of raw materials and essential manufactured goods in those years. The effects of that lack of policy were neither local nor transitory. The penury of European countries induced them to husband their resources by quantitative restrictions on exports and on imports, and the fear of their lowered standard of living induced others to refuse to accept their products. Commercial policy was driven from the very outset down the wrong road and never found another. In 1918 productive capacity in Continental Europe was at an extremely low level; in 1919 industrial production was about one half, agriculture one third, below normal. During 1919 and 1920 Continental

Europe imported about 17·5 billion dollars worth of goods from overseas, against an export of only 5 billions. Foodstuffs and finished goods formed an unusually large proportion of these imports; the imports of raw materials were relatively small. Northern and western Europe received proportionately much larger supplies than central and eastern Europe. The import surplus was met mainly from shipping services (1·8 billion dollars), emigrants' allowances (1·4 billions), expenditures in Continental Europe of the American and British armies (about 1 billion), yield on foreign securities (0·7 billion), inter-governmental loans (about 2·8 billion, of which 0·9 billion were relief loans), liquidation of security portfolios, and to the extent of roughly 2·5 billions from short-term credits.

Food was supplied by relief organizations, mainly during the first half of 1919, after which relief deliveries were on a much reduced scale. No international plan was evolved for the provision of the war areas with the other goods essential for the restoration of their economic life for nearly two years after the Armistice. The ter Meulen Plan, presented to the Brussels Conference in October 1920, for raw material credits, came too late and failed to materialize, and States were forced to acquire raw materials within the limits of their own financial capacities. The absence of provision for raw material credits was an essential factor in the process of currency depreciation, inflation and hyper-inflation. Inflation and currency depreciation in their turn caused a violent redistribution of national income and wealth, and prepared the ground for social unrest and political agitation. Action was only taken when inflation and the threat of social upheaval rendered it an unavoidable political necessity. This study gives a striking reminder of the magnitude of the disaster that resulted from the absence of any general plan, the failure of production and trade to revive, the social and political effects of inflation and the extent to which those effects were accentuated by the depression at the end of the first peace decade, and that depression accentuated by the burden of debt that Europe had assumed.

Canadian Seed Potato Eye Trade

By means of regulations issued in 1940, the Canadian Department of Agriculture exercises a strict control over the trade in seed potato eyes in the Dominion, where the raising of potato crops from eyes rather than from whole tubers is the usual practice in remote areas to which the transport of seed tubers is difficult. Eyes for sale must be cut only from certified seed, and their weight must be such that thirty-five eyes weigh not less than 1 lb. If the eyes are to be stored they are kept first for a week at 75° F. to encourage cork formation, but subsequent storage is at lower temperatures. Eyes intended for dispatch to growers soon after being cut have the cut surface either dusted with limestone or waxed to prevent drying out. The eyes must be free from obvious fungal, bacterial and insect damage and must be shipped in specified types of cartons, and with each batch of eyes sold a copy of the directions for planting issued by the Department of Agriculture must be sent. The directions for planting indicate the desirability of planting the eyes as soon as they are received in moist soil and with adequate protection against drying out. If planted in dry soil the eyes may fail to develop. The recently described experiments at Kew suggest that some of the precautions against drying out of the eyes may be unnecessary and that the use of controlled drying to produce 'dried potato eye chips' would further reduce the weight but not the viability of the eyes and so further simplify the difficulties of transport to remote areas.

Treatment of Cancer

The annual report for 1943 of the British Empire Cancer Campaign directed attention to recent developments in the treatment of cancer. In particular, reference was made to encouraging work on the inhibition of cancer of the mammary gland and of the liver by diets; and that it has been possible to confirm statements of workers in the United States and Canada, who claimed that the symptoms of cancer of the prostate are inhibited by the administration, in the simple form of pills given by the mouth, of diethylstilbœstrol, a synthetic substance resembling other glandular products. This is a very great advance; but we shall do well to remember that, although diethylstilbœstrol relieves the symptoms of this form of cancer and makes the patient once more a useful citizen, its effects are not yet uniformly successful and no surgeon has yet claimed to cure cancer in this way. The treatment applies, moreover, to only one form of cancer. These cautions do not minimize the greatness of the advance; they are necessary only because the public is acutely sensitive to any statements about cancer research, and insists that it must not be misled about a subject which only the expert can properly understand.

The public is right to insist upon this. It should remember, nevertheless, that cancer research is still a charity mainly dependent upon the gifts of public-spirited individuals. These benefactors, as well as the general public, have a right to be sure that the work made possible by their gifts is well co-ordinated and properly controlled, and that its results are passed on to the public through the proper channels. A recent announcement issued by the British Empire Cancer Campaign will help to reassure them about this. The Campaign intends to keep practising medical men informed about the progress of cancer research, so that the public may have, through them, the advice of the Campaign's experts about suggested cancer treatments. The Campaign also intends to do all that it can to promote investigation into methods of treatment of cancer and into theories of its causation, stipulating only that full disclosure shall be made of the nature and method of use of suggested treatment, and so on. To these conditions no reasonable man can object. They are, in essence, the conditions which any scientific worker imposes upon himself whatever the nature of his scientific work may be.

Malaria in the South-West Pacific

A new campaign to combat malaria in the South-West Pacific is to be financed under the Colonial Development and Welfare Act, 1940, and an initial grant of £65,000 to cover three years has been made for the purpose. The Anopheles mosquito, and consequently malaria, has hitherto been unknown in the territories of Fiji, Tonga, the Cook Islands, the Loyalty Islands, New Caledonia, the Gilbert and Ellice Islands and Samoa. In the islands to the west of Fiji, on the other hand, malaria is widely distributed. In peace-time, when there was little shipping traffic between the islands and air

services were unknown, the danger of the spread of infection was small, and the routine malaria control was considered sufficient. But since the outbreak of war, the establishment of large garrisons and the increase of air and sea traffic between the islands has greatly increased the danger of introducing malaria to the 'clean' islands. It is no longer safe to rely on quarantine measures; so steps are to be taken to eliminate possible places where Anopheles might breed.

Entomological surveys are to be made near shores and ports, and reconnaissance surveys of all potential breeding grounds. Normal anti-mosquito work will be intensified and danger places will be cleared, drained and oiled where necessary. At the same time an engineer will prepare a scheme for mosquito control on a long-term basis. The financial grant will cover the cost of plant, such as transport vehicles, garages, laboratories, equipment and tools, and the salaries of an engineer, surveyors, overseers, clerks, drivers and labourers for a period of three years. The measures to be taken will also wipe out the mosquitoes, other than Anopheles, already present in Fiji, which are carriers of such diseases as dengue fever and filariasis, and which would be a serious menace if yellow fever should ever be introduced to the territory.

Dehydrated Graphite Sols

DILUTE solutions of aqueous colloidal graphite have proved of service by their ready formation of electrically conductive, lubricative and opaque films (see NATURE, 149, 298; 1942). Bernard H. Porter, 25 South Street, Houlton, Maine, states that highly concentrated dispersions of the same colloid, compressed and dehydrated, constitute effective small-parts substitutes for metal. Irreversible in character, dehydrated masses of colloidal graphite are electrically conductive, markedly resistant to high temperatures, chemically inert, gas absorbent and easily machined. The commercial form of graphite hydrosol is slowly baked in pressure moulds at 90° C. Shrinkage may be so high as 85 per cent by volume. The resistivity of dehydrated graphite baked at 105° C. without pressure is 28·21 ohm-cm.; its porosity 24·93 per cent. Bars having greater conductivity than the graphite alone are formed by embedding strands of No. 30 copper wire, or strips of 60-mesh screen, in the graphite paste before baking. Metallic dusts may be admixed for the same purpose, though not without decreasing the tensile strength of the dried solid. Machine shaping, tapping and threading may follow as desired. Guard rings, connectors, electrodes, contacts, special-purpose forms and small parts normally made of metal are applications for dehydrated graphite sols.

Teletypewriter Test Sets

DISTORTIONS in teletypewriter signals are classified in three groups: bias, characteristic distortion, and fortuitous distortion. Bias, due to asymmetry in the circuit, causes all marking impulses to be lengthened or shortened. The increase or decrease is substantially equal in all the marking impulses, and the amount of bias is the lengthening or shortening expressed as a percentage of the unit pulse. As interpreted by a teletypewriter, the lengthening or shortening is what it would be if the bias affected only the beginnings of the marking impulses. Characteristic distortion differs from bias in that the amount of the distortion may vary from impulse to impulse and is dependent on the combination of the preceding impulses. Fortuitous distortion is normally non-repetitive and is caused by random interference such as cross-fire, lightning or power induction.

A teletypewriter test set has been developed by the Teletype Corporation (U.S.A.), which transmits code impulses corresponding to teletypewriter characters and distorts their timing relative to the start pulse by segments on two concentric rings over which conducting brushes are motor-driven at a constant speed. By adjusting the outer ring with respect to the inner one and connecting the segments of the two rings either in series or parallel, signals may be produced with any desired amount of marking or spacing bias, or marking or spacing end distortion. An article by W. Y. Lang (*Bell Lab. Rec.*, **21**, No. 12; August 1943) describes and illustrates the set.

Directory of Natural History Societies

A "Directory of Natural History Societies" in Great Britain and Ireland is now in course of preparation for publication by the Amateur Entomologists' Society in the near future. Its aim is to make known the existence and work of societies interested in any branch of natural history (except economic, agricultural or medical problems). The compilers wish to include as large a number of such organizations now existing in Great Britain and Ireland as can be brought to their notice, from national associations and regional unions to county, town, university or school societies. Names and addresses of as many organizations as possible, particularly of the smaller clubs and societies not affiliated to any naturalists' union, school or college organizations, and the like. are now needed, and the compilers will be glad of any help that readers can give. Postcards or letters should be addressed to Mr. W. G. Rawlings, 14 Westfield Park, Bath.

Merseyside Fauna and Flora

THERE is much that has more than a local interest in the recently issued Portfolio Vol. 2 of the Merseyside Naturalists' Association, covering mainly field work in 1942. From the botanical interest, J. D. Massey discusses in a lengthy paper the changes in the flora of the Liverpool area from 1838 to 1943, during which period fifty-nine plants have become extinct, forty-six native British species have become naturalized in the district, there have been seventy-eight naturalized alien incomers, while some 250 casuals have been recorded. The flora of this district is specially interesting from the influence of shipping introductions, of industrial slag heaps, building, drainage and pollution. Eric Hardy has a note, with photographs, of a large and well-established sycamore tree (*Acer pseudo-platanus*) growing entirely parasitically from a cleft in an alder tree (*Alnus glutinosa*) at Ince Blundell, South Lancashire. T. Edmondson has a survey of the avi-fauna of a mile-long colliery lake at Leigh with 109 birds, comprising forty residents, eleven summer visitors, fourteen passage migrants, twelve winter visitors and thirty-two occasional visitors, including such interesting species as gadwall. pintail, Bewick's swan, goosander, smew, bittern, red-necked phalarope; from the migration of waders and duck, it may be part of a route across the north of England. G. C. Miller has made some detailed and statistical studies of the nesting of the house sparrow, *Passer d. domesticus*, in which

he suggests that it is probable that three broods are reared when nesting begins early in April and only two when nesting is delayed by weather until May; the period between rearing one brood and commencing another averages ten days, making altogether 113 days or an average of four months devoted to the rearing of their young. There is confirmation of the observations of B. H. Ryves (*Brit. Birds*, August 1943), including retardation of egg-laying due to inclement weather. After the destruction of previous clutches the rapidity of egg-laying produced fresh eggs after intervals of only four or five days. An average of five young per pair is a normal seasonal increase. There are also interesting observations on the building of domed nests inside nest-boxes.

Powdery Mildew of the Rose

HORTICULTURAL beauty of the rose often depends as much on the foliage as upon the flowers. Powdery mildew caused by the fungus *Spaerotheca pannosa* is a very widespread trouble upon the leaves, particularly when roses are grown under glass. The disease can be minimized, but not controlled, by keeping temperature and humidity as low as possible for the growth of the plants. Mr. Wilbur D. McCellan has re-investigated the problem of control, chiefly by spraying methods (Cornell University Agricultural Experimental Station, Bull. 785. Ithaca, N.Y.; June 1942). Sulphur-containing sprays were found to be generally superior to those containing copper, though malachite green gave the best eradicant control. Good control without injury to foliage resulted from the use of particulate sulphur. Various wetting agents were also studied, and useful control was obtained by vaporizing sulphur at 112–115° C. A considerable reduction in the amount of mildew can be obtained by frequent syringing. The paper also includes descriptions of a method of measuring contact angles of spray drops, as a means of comparing their wetting power.

Mammalian Reproduction

THE title of a recent publication (1943) of the Imperial Bureau of Animal Breeding and Genetics fully indicates its contents. It is "Gestation Periods, a Table and Bibliography", compiled by J. H. Kenneth (Pp. 23. Edinburgh and London: Oliver and Boyd, 1943. 2*s*.). It contains a very long list of mammals with their common and scientific names, followed by the time in days of their gestation periods. The average time is given and also the minimum and maximum times where available. Where different times are given by different authorities, these are cited separately and all data are followed by references to the publications from which they are taken. In domestic mammals, separate times are given for the different breeds and in some instances for crosses between them. A number of workers will be grateful for this ready access to a scattered literature. A wide range of variation is shown from the sixteen days of the golden hamster, *Mesocricetus auratus*, up to the 426 days of the okapi, *Okapi johnstoni*, and 641 days of the elephant, *Elephas indicus*.

Health of Iceland

ACCORDING to the *Medical Officer* of November 13, the population of Iceland is now 121,579, of which 38,300 live in the capital, Reykjavik. The marriage-rate is 6·6, the death-rate 9·9 and infant mortality 35·9 per 1,000 live births. The chief causes of death are old age (1·6 per 1,000), closely followed by diseases of the heart and cancer, which both reach 1·3 per 1,000. Apoplexy, tuberculosis, pneumonia and accidents all rank about the same (0·8–0·9 per 1,000). Apart from influenza and pneumonia, infectious diseases are not important causes of death. Scarlet fever and erysipelas are of a much more virulent form than in Great Britain. 229 cases of tuberculosis were notified, of which 60 were non-pulmonary, and 104 cases were fatal. School medical inspection of children especially as regards tuberculosis is compulsory. Venereal disease is notifiable, and there has not been a diminution of cases during the last ten years. Occupation by foreign troops has been followed by more employment, more money, higher prices, longer working hours, housing difficulties, more accidents in factories and on roads and increase in immorality.

Typhus Fever in Bolivia

ACCORDING to the delegate of Bolivia at the eleventh Panamerican Sanitary Congress at Rio de Janeiro during September 7–15, 1942 (*Bol. Of. San. Panamer.*, 22, 590; 1943), typhus fever, which was formerly confused with typhoid fever, is an endemic disease which causes serious epidemics in Bolivia in the winter months. Its centre is the high Andean Plateau which has a million inhabitants, 90 per cent of whom are natives. The largest city affected is La Paz, which is in direct contact with the Indian population of the highlands as a trading, commercial and supply centre. The disease occurs only sporadically in the valleys, although they are inhabited by the same kind of natives as those on the plateau. During the Chaco campaign, when thousands of plateau natives were fighting among the rest of the inhabitants under lice-infested insanitary conditions, not a single case of epidemic typhus occurred, although in 1933 and 1935 the plateau was suffering from a great epidemic. During the last two years, cases of typhus have been uncommon and have been replaced by relapsing fever. The probable explanation of this is that the virus of the disease (*Rickettsia prowazeki*) is of a special type adapted to the Bolivian plateau and unable to flourish in a warmer climate, or that the lice in the valleys for some unknown reason do not transmit the disease.

Cerebrospinal Meningitis in War-time

ACCORDING to the July issue of the *Statistical Bulletin*, the organ of the Metropolitan Life Insurance Company of New York, cerebrospinal meningitis recorded its most extensive outbreak in the history of the United States in 1943: the number of cases up to the end of July was more than 13,000, and the total for the year will probably exceed 17,000 cases. Practically every part of the United States has been attacked, the State most affected being Rhode Island. Earlier, the disease was at an extremely low ebb, but in 1942 new cases began to increase in number. A large proportion of the cases reported in 1943 occurred in Army camps. England has probably suffered from cerebrospinal fever more than any other belligerent in this War, especially during 1940 and 1941, when the number of cases was nearly ten times the average for the three previous years. As the result, however, of the introduction of sulpha drugs in 1943, the majority of cases are now cured and the treatment of the disease has been revolu-

tionized. In the American Army camps, the death-rate has been only $3\frac{1}{2}$ per cent as compared with 34 per cent in the War of 1914–18; relapses have been virtually eliminated and the frequency of complications has been greatly reduced.

Training in Special Librarianship

THE very great increase in information services has created a demand for special librarians and information officers far in advance of the available supply of trained librarians. The Association of Special Libraries and Information Bureaux is therefore continuing to organize its emergency training in the technique of the special library by means of courses of twelve lectures given at weekly intervals, the first of which will start on February 16. Naturally such courses cannot pretend to give a complete training in librarianship; they are intended as first-aid help for inexperienced assistants in special libraries or information bureaux in place of the more thorough training not obtainable through war conditions. In the light of the experience gained in 1943, modifications have been made in the syllabus, which can be obtained on application to the General Secretary, ASLIB, 31 Museum Street, London, W.C.1. A fee of five guineas per student is charged for the course.

Clough Memorial Research Fund

THIS fund was instituted in 1935 for the purpose of encouraging geological research in Scotland and the north of England, the latter defined as comprising the counties of Northumberland, Cumberland, Durham, Westmorland and Yorkshire. A sum of approximately £30 is available annually. Applications for grants for the period April 1, 1944, to March 1945 are invited. Applications should state the nature of research to be undertaken, the amount of grant desired and the specific purpose for which it will be used, and whether any other grant-in-aid has been obtained or applied for. Applications must be in the hands of the Secretary, Clough Research Fund Committee, Edinburgh Geological Society, Synod Hall, Edinburgh, not later than March 1, 1944.

Recent Earthquakes

DURING September 1943, ten strong earthquakes were registered at the Dominion Observatory, Wellington, New Zealand. Epicentres have been determined at the Observatory as follow: September 6, near Macquarie Island; September 14, (1) near New Caledonia; (2) Samoa region; (3) region of 26° S., 175° W.; September 17, near Solomon Islands; and September 27, in the Kermedecs region. Sixteen other earthquakes and tremors were felt in New Zealand during the month. The strongest of these was Scale IV on the Modified Mercalli scale, and shocks with this intensity occurred on (1) September 3, in parts of Canterbury and Westland; (2) September 12 in Otira and near Arthur's Pass; and (3) September 28 at Eketahuna. Seismographs at Toledo in Spain registered twenty-two strong earthquakes during September 1943, the shocks of September 6, 10 and 14 being described as violent.

During the period Sept. 11–Nov. 26 inclusive, twenty strong earthquakes were registered at Kew Observatory. By far the largest ground vibration amplitudes at Kew were on Nov. 26, 1120 μ; Nov. 6, 590 μ; Oct. 23, 340 μ; and Nov. 3, 330 μ. The shock of Nov. 26 was in Turkey and has already been reported in NATURE (Dec. 11, p. 684). The shock of Nov. 6 was probably the one with epicentre just west of the island of Aroe Eilanden in the Banda Sea (lat. 5·5° S., long. 134° E.). The earthquake of October 23 probably had its epicentre 30 miles east-north-east of Sylhet in Assam, while that of November 3 probably originated 30 miles north-west of Susitna in Alaska. The last three mentioned epicentres were determined provisionally by the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association on instrumental evidence. The next largest amplitudes during the period at Kew were Nov. 24, 105 μ; Oct. 24, 32 μ; Sept. 24, 28 μ; Oct. 22, 25 μ; Oct. 16, 21 μ; and Oct. 21, 17 μ. The last-named had its epicentre determined by the U.S. Coast and Geodetic Survey as being near lat. 16·5° S., long. 178° E., which is in the Pacific Ocean due north of the island of Vita Levu and due west of the island of Vanua Levu, both of the Fiji Islands group.

Announcements

THE Council of the Institute of Metals has elected four honorary members of the Institute, one each from the four principal Allied Nations: Her Excellency Madame Chiang Kai-Shek (China); Sir Lawrence Bragg (Great Britain); Dr. Irving Langmuir (United States of America); Prof. P. Kapitza (Union of Soviet Socialist Republics).

THE Astronomer Royal, Sir Harold Spencer Jones, will deliver the 1944 May Lecture of the Institute of Metals. He has chosen as his subject "Metals in the Stars".

THE Council of Newnham College, Cambridge, has awarded a Muriel Wheldale Onslow Prize for outstanding work in biology to Dr. A. B. Beakbane, of the East Malling Research Station.

PROF. J. MCLEAN THOMPSON will read a paper entitled "Towards a Physiological Interpretation of Modern Flowering", before the Linnean Society on February 10, at 2.30 p.m.

DR. PAUL HERGET, formerly assistant professor of astronomy at the University of Cincinnati, has been appointed director of Cincinnati Observatory in succession to the late Dr. Elliott Smith, and has been made professor and head of the Department of Astronomy in the University of Cincinnati. Dr. Herget, who is thirty-five years old, is an authority on celestial mechanics, having specialized on the computation of the orbits of minor planets and comets.

AT the annual meeting of the New York Academy of Sciences held on December 15, the following were elected to honorary life membership: Dr. O. T. Avery, of the Rockefeller Institute for Medical Research, New York; Prof. Alexander Fleming, professor of bacteriology, University of London (St. Mary's Hospital Medical School); Sir Frederick Gowland Hopkins, recently Sir William Dunn professor of biochemistry in the University of Cambridge; Dr. Alfred L. Kroeber, director of the Museum of Anthropology, University of California; Prof. The Svedberg, head of Physical Chemistry Institute, University of Uppsala; Prof. Arne Tiselius, professor of biochemistry, University of Uppsala.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Statistical Mechanics of Fields and the 'Apeiron'

In view of the difficulties encountered in the quantum theory of fields, we have developed a new approach to this subject which bears a much closer resemblance to ordinary quantum mechanics of particles than the existing theories (Heisenberg and Pauli). We consider the field in a finite volume Ω as a mechanical system described by its total energy and momentum. The latter are obtained from the classical expressions for the energy-momentum densities simply by multiplication with Ω. Each field component is considered as an operator (for the whole volume Ω) and is not regarded as a function of the co-ordinates at all. Between the field components we have established very simple commutation laws, analogous to the ordinary law $pq - qp = \hbar/i$, which depend on the transformation character of the field considered. For example, for the scalar meson field (potential v, its gradient f, its time derivative g; * means Hermitean adjoint; $[a, b]$ means $ab - ba$):

$$[v, g^*] = [v^*, g] = i\frac{\hbar c}{\Omega},$$

$$[g^*, f] = [f^*, g] = k\frac{\hbar c}{\Omega}.$$

Here the vector k is just an abbreviation for the commutators; it is a dynamical variable, but in virtue of the commutation laws a constant of motion, that is, it commutes with all field quantities, with the energy and the momentum.

We have verified[1] that in this case, and also for all other known fields, these commutation laws (or in the case of electrons similar anti-commutation laws) lead, with the transcription

$$[p_x, f] = \frac{\hbar}{i}\frac{\partial f}{\partial x}, \; [E, f] = -\frac{\hbar}{i}\frac{\partial f}{\partial t},$$

to the complete set of field equations and yield the same results as the usual quantization method (integral number of quanta with half-quantum zero energy).

But there appears a completely new feature of fundamental importance in the theory, connected with the vector k introduced above. It turns out that k corresponds to the geometrical variable 'wave vector' introduced by Fourier analysis in the usual theory. But it is here a real dynamical variable; its eigen values together with other quantum numbers define the pure states of the field. The distribution of these eigen values depends on the shape of the volume Ω, but can be assumed for a large volume to be uniform in the k_x, k_y, k_z-space (forming a cubic lattice).

In quantum mechanics it is necessary to introduce, apart from pure states, linear combinations of such, called mixtures; but it is not necessary that every possible state should appear in a mixture. (That is the main difference between our new theory and the usual one, because there each Fourier coefficient, considered as a q-number, necessarily appears, having at least its zero energy). A mixture contains in general a selection of k-points, each of which may still be occupied by any one of the quanta of the kind considered.

It is necessary to have a name for this sub-group of pure states belonging to the same k-value, which is something intermediate between the ordinary notion of a quantum (or particle) and a mechanical system. We suggest to use the word 'apeiron', introduced by the Greek philosopher Anaximander (about 550 B.C.) for the boundless and structureless primordial matter.

For a definite system (pure field) no mechanical knowledge is available to decide which apeiron may appear (which k-points are occupied by apeirons). Therefore we have to apply statistical methods. This is a new type of statistics, to be distinguished sharply from the ordinary distribution of quanta over the possible quantum states. For example, in the case of the scalar meson field referred to above, one has not only to assign the number of positive and negative mesons N_k^+, N_k^- (equal to 0, or 1, or 2, . . .) of a specified apeiron k, but also the number Δ_k (equal to 0 or 1) which indicates whether a place in the k-space is occupied by an apeiron or not. Both distributions must be made simultaneously; the N_k satisfy in this case the Bose-Einstein statistics (in the case of electrons the Fermi-Dirac statistics), while the n_k evidently always belong to the Fermi-Dirac type of statistics.

If, therefore, the total number of apeirons is a given number n, the distribution of $\bar{\Delta}_k$, the mean value of Δ_k, as a function in the k-space has the features well known from the electron theory of metals. For low temperatures all k-points are occupied up to a finite limit $|\,k\,| = k_m$, while all places with higher $|\,k\,|$ are empty. For higher temperatures this rectangular distribution curve becomes rounded off at the end, but in any event the function $\bar{\Delta}_k$ falls exponentially to zero for $|\,k\,| \to \infty$. If $\varepsilon_k\left(N_k^+, N_k^-\right)$ is the energy for the apeiron k in the occupation state N_k^+, N_k^- (for example, for the scalar meson field: $\varepsilon_k = \varepsilon_k{}^0\left(N_k^+ + N_k^- + 1\right)$) the total energy is $E = \sum_k \Delta_k \varepsilon_k$; it behaves as if the field were a Fermi-Dirac gas of molecules each of which was an apeiron and therefore had an infinity of states corresponding to the numbers N_k^+, N_k^- of quanta. If now Δ_k is replaced by its average $\bar{\Delta}_k$, the sum E will converge in spite of the zero energy $\varepsilon_k{}^0$ which is proportional to $|\,k\,|$.

It is to be expected that all divergent sums and integrals of the usual photon and meson theory are made convergent by the proper application of the apeiron statistics. In the case of collision phenomena, one has no thermal equilibrium; but the transition probabilities depend not only on the initial and final state but also on all possible 'intermediate' states. The cross-section integrals are extended over the statistical apeiron distribution.

The magnitude of the total number n of apeirons in thermal equilibrium has to be chosen in such a way that the self-energies of the elementary particles are correctly represented; that means that the upper limit k_m of the filled part of the k-space is connected with the radius r_0 of the electron by a relation of the kind $k_m r_0 \sim \hbar$.

The case of the electronic field can be treated in such a way that the contribution to the energy of each electron and positron is positive. But then there is a

negative zero energy, and therefore no thermal equilibrium of the apeiron is possible. This does not seem to us to be a real difficulty, because a set of electrons left to themselves is not in equilibrium. Electric clouds like those in metals exist only on account of the fact that in this case the interaction energy with other particles (which is omitted in our considerations) is large compared with the thermal energy.

Investigations on the application of this theory to the elementary particles, their masses and their mutual collision cross-sections are in progress.

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[1] *Proc. Roy. Soc. Edinburgh* (in the press).

Rate of *n*-fold Accidental Coincidences

THE rate of accidental coincidences between two Geiger counters is given by $R_2 = 2.N_1.N_2.t$, where N_1, N_2 are the rates of the two single counters and t is the resolving time of the recorder. This formula is sometimes generalized for n-fold coincidences as $R_n' = N_1.N_2 \ldots N_n.(2t)^{n-1}$. This formula is, however, incorrect and it should be replaced by

$$R_n = n.N_1.N_2 \ldots N_n.t^{n-1} + \text{terms in } t^n. \quad . \ (1)$$

As the formula for the rate of accidental coincidences is of practical interest, and I have not come across its derivation, a short explanation follows.

Consider a pulse of the counter 1 at the time 0. A necessary condition for this pulse to be recorded as an n-fold coincidence is that in the interval $\pm t$ each of the remaining $n - 1$ counters gives rise to at least one pulse. Neglecting all but the lowest power of t, the probability for this is

$$P = N_2.N_3 \ldots N_n.(2t)^{n-1} \quad . \ . \ . \ . \quad (2)$$

The pulse of the first counter, together with the $n - 1$ pulses of the other counters, only gives rise to a coincidence if the interval between any two of the pulses is less than t. The probability Q that $n - 1$ pulses of the counters $2, 3 \ldots n$ all inside the interval $\pm t$ are suitably arranged to give a coincidence is estimated as follows.

The $n - 1$ pulses may all be in the interval $0 - t$. The probability for this is

$$Q_1 = 2^{-(n-1)}.$$

In this case the pulses give rise to a coincidence.

Alternatively, the first pulse x of the group may be in the interval $-t', -t' + dt'$ and the remaining $n - 2$ pulses inside the interval $-t', -t' + t$. The probability for this is $(n-1)\ (dt'/2t)2^{-(n-2)}$; the pulses again give rise to a coincidence. The probability for a coincidence while some pulses are in the interval $-t$ to 0 is thus

$$Q_2 = \int_{-t}^{0} (n-1)2^{-(n-2)}\frac{dt'}{2t} = (n-1).2^{-(n-1)}.$$

The total probability is

$$Q = Q_1 + Q_2 = 2^{-(n-1)}.n \quad . \ . \ . \ . \ . \quad (3)$$

Thus the probability that $n - 1$ pulses fall into the interval $\pm t$, and that these pulses are suitably arranged to give a coincidence, is found from (2) and (3) as

$$P.Q = n.N_2.N_3 \ . \ . \ . \ N_n.t^{n-1}.$$

The above expression multiplied by N_1 gives equation 1.

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Comparison of the Behaviour of Rubber-like Materials under Constant Stress and Constant Strain Conditions

MANY experimental data have been published substantiating the use of the Nutting equation,

$$\psi = S^{\beta}\sigma^{-1}t^{k},$$

where S is shear stress, σ is strain, β, k and ψ are constants, when a series of constant stress experiments is performed. Our own as yet unpublished results confirm the equation over an even wider range of materials.

For relaxation experiments, test pieces are given a definite strain as rapidly as possible, the resulting internal stress being then allowed to dissipate with no more change of strain than is required to operate a strong spring whose deflexions, which record the stress, can be read by optical magnification.

According to Maxwell's equation[1], the rate of stress dissipation should be proportional to stress itself, but many authors have shown that this is not so for most complex materials. Simha[2,3], notably, has discussed whole spectra of relaxing systems each of which is Maxwellian and has its characteristic relaxation time (t_r).

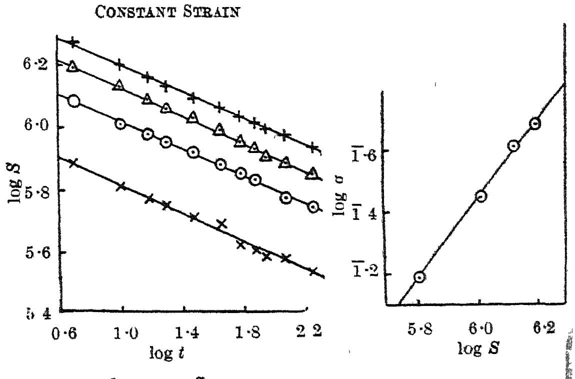
The appropriate fractional differentiation of Nutting's equation gives

$$\left(\frac{\partial S}{\partial t}\right)_{\sigma} = -\frac{k}{\beta}\frac{S}{t}.$$

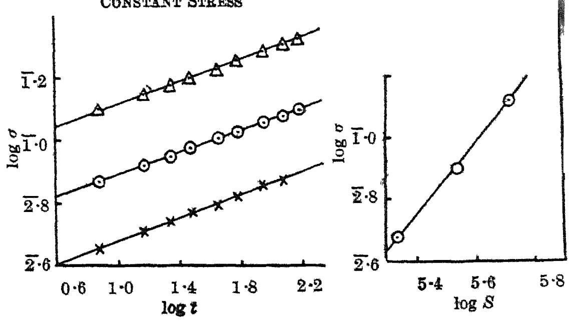
Maxwell himself suggested that in complex materials t_r might well be a function of S, and the above equation is perhaps the simplest expression of this suggestion, since t_r is proportional to a power of the stress.

We have investigated a number of rubbers and rubber-like materials in tension and a few in compression, and with the exception of some very soft materials, find little if any deviation from linearity when log S is plotted against log t for a series of

CONSTANT STRAIN



CONSTANT STRESS



constant strains. Such curvature as there may be suggests still further deviation from the Maxwell plot.

It is also interesting that the values of k, β and ψ (or $1/\zeta$, the volume of the $S : \sigma : t$ figure[4]) calculated from constant stress (compensating for the change in cross-section) and constant strain experiments are so nearly the same that differences can scarcely be much greater than experimental error. This is rather striking, since, as Scott Blair and Caffyn[5] have pointed out, in the former type of experiment k is determined from the continuous change of strain with time, whereas, in the latter, since the slope of the experimental curve is k/β, data from a series of different experiments have to be introduced. The curves deriving β are, naturally, less accurate in both experiments than are the 'continuous' curves.

This treatment seems to us to present a much simpler way of viewing the relaxation behaviour of complex materials than is the concept of a spectrum of Maxwellian components, but further data will be needed before the full extent of its applicability can be assessed.

The figure shows typical experimental curves. The derived curves, relating stress to strain for a defined time, are given on the right of the diagram.

Our thanks are due to the British Electrical and Allied Industries Research Association for a grant.

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[1] Maxwell, J. C., *Phil. Mag.*, 35, 129 (1868).
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Ice-Crystal Haloes

BRAVAIS, in his great memoir[1] on this subject, divides circumzenithal arcs into two classes, ordinary and extraordinary. "Les arcs circumzenithaux ordinaires sont les arcs tangents aux halos de 22 degrés et de 46 degrés."

There are two arcs tangent to the halo of 46°, an upper and a lower. The upper is much the more frequent, and unquestionably the most brilliant of all those connected with haloes and parhelia. It encircles the zenith and always appears about 20°–25° from it. The colours are as brilliant as those of the rainbow, the red border being towards the sun and the blue border towards the zenith. It often appears unaccompanied by the halo of 46°.

According to Galle, the tangent arc to the halo of 46° is due to refraction of light through hexagonal prisms terminated by planes perpendicular to the hexagonal axis, the prisms being distributed and fixed with that axis vertical. The light enters obliquely at the upper basal face and comes out through the adjacent vertical face. Bravais showed that the effect of this arrangement would be to produce an arc concave toward the zenith when the altitude of the sun was less than 20°, and concave downward when the sun's altitude was greater than 20°. But such a reversal of curvature has never been observed, so Galle's explanation does not meet the case.

Bravais's own explanation of this arc is based on the very reasonable supposition that the crystals are not fixed, but oscillating or fluttering through a small angle about the vertical. The greater the amplitude of oscillation the more are the colours of the arc mixed together, and especially so when the sun's altitude is less than 16° or greater than 28°; but the red remains pure.

In order that the crystals may flutter about their hexagonal axis, one must suppose that they are of tabular habit; for as Wood has pointed out[2], Bravais was wrong in supposing that snow crystals are in the position of least resistance while falling.

The conclusions to be drawn from all this are that: (i) the common circumzenithal arc and the arc tangent to the halo of 46° are one and the same thing; (ii) the tangent arc of the 46° halo is not invariably accompanied by the halo itself; (iii) tabular hexagonal crystals fixed as in Savile's Fig. 1[3] give rise to Galle's arc. Precisely the same type of crystal, when fluttering, gives rise to the upper tangent arc to the 46° halo.

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Hydrogen Content of the Sun and of Stars of Small Masses

THE simple Cowling model of a star of small mass with a convective core and radiative envelope is of considerable importance in view of Bethe's theory of energy generation, which demands a stellar model of the convective radiative type. It appears possible to use this simple model so as to conform to Bethe's formula of energy generation on one hand and furnish an approximate value of the hydrogen content of a star of small mass on the other. For formulæ relating to the Cowling model we shall refer to Chandrasekhar's "Introduction to the Study of Stellar Structure", pp. 351–54. The constant $\varkappa_0$ in Kramers' opacity formula will be taken as $3\cdot9 \times 10^{25}(1-x^2)/\bar{t}$, where $\bar{t}$ is the mean guillotine factor, and x the hydrogen content; helium content being assumed zero.

It may be noted that the substitution of the observed L, M, R of a star in the Cowling model formulæ may lead to a serious discrepancy with Bethe's energy generation formula. For example, in the case of the sun the substitution of L, M, R in the formula of the Cowling model (Chandrasekhar, *loc. cit.*, ix, 206, 208 and 209) would give for $\bar{t} = 5$ (Strömgren):

$$T_c = 21\cdot4 \times 10^6 \text{ K.}, \rho_c = 52\cdot3 \text{ gm./cm.}^3, \quad \mu = 1\cdot028, X \sim 0\cdot31.$$

But if the stellar equations of equilibrium be integrated *from the centre outwards* with these T_c, ρ_c values, and the luminosity calculated by Bethe's formula be used to determine the change to radiative gradient as usual, we shall arrive at an all-convective model—there will be no radiative envelope. This situation is expected to arise quite generally for this type of adjustment.

If μ, ρ_c and T_c be given, we can, on one hand, calculate the luminosity L_{Cow} by the Cowling model formula, and also another value of the luminosity L_{Beth} by integrating Bethe's formula from the ς, T values inside the core within which nearly the whole of the energy generation is found to take place. Suppose now only μ is assigned, and T_c and ς_c are

so chosen that $L_{\mathrm{Cow}} = L_{\mathrm{Beth}}$ = luminosity of the given star. From the Cowling model formulæ (Chandrasekhar, *loc. cit.*, ix, 208, 209), we can calculate M and R for the star, which may be compared with the observed values. The adjustment of the equality of the luminosities may be made thus. We obtain

$$L_{\mathrm{Beth}} = 4\pi\varepsilon_0\left(\frac{5k}{8\pi\mu GH}\right)^{3/2} T_c^{5/6}\rho_c^{1/2}\int_0^{\xi}\theta^{7/3}e^{-b/\theta^{1/3}}\xi^2\,d\xi$$

$$= A\rho_c^{1/2}\,I(\xi,T_c),$$

I representing the integral and $b = 56 \times (2\times 10^7/T_c)^{1/3}$. Also the Cowling model formula gives

$$L_{\mathrm{Cow}} = B/\rho_c^{5/2},\ B = 0{\cdot}1968 \times \frac{16\pi ac}{3K_0}\left(\frac{5k}{8\pi\mu GH}\right)^{1/2} T_c^{8}.$$

Equating the two values of L at the interface ξ_i of the convective core, we obtain for a definite T_c the corresponding density by

$$\rho_c^3 = \frac{B}{AI(\xi_i,T_c)}.$$

By trial, T_c may now be so adjusted that the calculated luminosities agree with the given luminosity of the star.

For the sun, taking $\mu = 1$, $X \sim 0{\cdot}35$, and $\bar{t} = 5$ (Strömgren), we obtain by such an adjustment (the luminosity neglected outside the core not exceeding 5 per cent, as shown by calculation)

$$T_c = 20{\cdot}3 \times 10^6\ \mathrm{K.},\ \rho_c = 43\ \mathrm{gm./cm.}^3,$$
$$M = 2{\cdot}1 \times 10^{33}\ \mathrm{gm.},\ R = 7{\cdot}6 \times 10^{10}\ \mathrm{cm.}$$

The agreement with the observed M and R is very close in this case. The integration from inside will give a convective-radiative model of the desired type. It appears that the best agreement of the Cowling model with Bethe's energy generation formula can probably be obtained in this manner. Further, it also opens up a possibility of approximately determining the hydrogen content (for zero helium content) of stars of small masses on the basis of the Cowling model by adjusting x in such a way that a fairly good agreement between the three observed and calculated stellar parameters is achieved by the above method. This, of course, tacitly assumes that the relative size and mass of the core of a star obeying Bethe's formula are approximately the same as those given by the Cowling model.

It would also appear that a solar model of the convective-radiative type in agreement with Bethe's energy generation formula should have a central temperature of about 20 million degrees (standard model), but the central density should be much lower than that suggested by the standard model.

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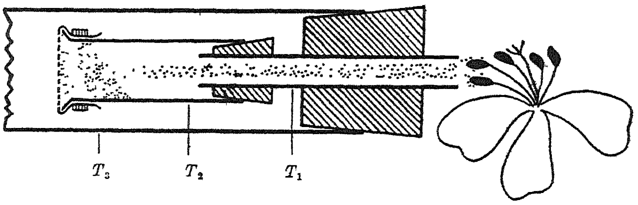
Collection of Pollen and Artificial Wind Pollination

THE collection of pollen for its immediate use or for storage is a common practice in plant breeding. No difficulties usually arise when the pollen is to be used at once, but if it is stored together with the anthers according to the usual technique, it is difficult to handle after the anthers have dried.

If pollen free from anthers is required, except in wind-pollinated plants, it is almost impossible to separate effectively the grains from the anthers by hand. Large amounts of clean *Oenothera organensis* pollen were needed for immunological experiments; but separation by hand was impossible because of the minute threads which connect the pollen grains in the Onagraceæ. This led us to devise a new method of pollen collecting based on air suction. A household vacuum cleaner with a suitable adaptor, shown in the figure, is extremely effective for collecting large or small quantities of pollen. The adaptor can be made from a piece of ¼-in. glass tube (T_1), and the top half of a 1-in. boiling tube cut into two (T_2). A piece of linen or other porous material is fixed with a rubber band around the flanged edge of the tube; a rubber bung, through which passes tube T_1, is pushed into the other end. The whole adaptor fits into the metal end of a vacuum extension tube (T_3). When the end of tube T_1 is placed near to the anthers of a flower, pollen is drawn in and trapped. By this simple device 1 gm. of clean pollen can be collected from fifty flowers of *Oenothera organensis* in less than four minutes, that is, 2·5 mgm. per anther.



After the pollen is collected it can be conveniently stored by removing the tube T_2 and corking the end. The best diameter of the collecting tube T_1 varies according to the type of flower. For Œnothera ¼ in. is suitable, but for radish half this diameter is better because with the large tube, petals are collected as well. For some flowers in which the anthers are well exposed, as in apples and cherries, a bell-mouthed tube can be used with the advantage of collecting from a cluster instead of individual flowers.

The device with the air current reversed can be used as a pollinator. A press-button valve releasing staccato puffs of air must be fitted between the fan and the pollen container. In this way a flower or a whole influorescence can be pollinated with one press of the button. An insect-pollinated flower is then wind-pollinated under controlled conditions. To regulate the amount of pollen delivered it can be diluted with a 'powder' such as Lycopodium spores or talcum; the degree of dilution varying with the type of flower. The method should greatly reduce the labour of mass pollination which is necessary in the breeding of fruit and forest trees in the temperate countries and in the breeding of dates, sugar-cane and bananas in the tropics. The increasing utilization of hybrid seed production in vegetables and fruit will also require mass pollination methods. Lack of adequate cross-pollination which may be due either to the planting of large blocks of one variety of fruit tree or to low insect activity has led occasionally to the use of hand collection and pollination in some 100-acre orchards[1]. If artificial pollination has to be resorted to on a big scale then the present method could be used with advantage. A similar method has been used on grape vines by spraying the flowers with a suspension of pollen in water[2].

Furthermore it will now be possible to measure

accurately and quickly the pollen production of plants, of which at present there is little knowledge. Such information is of biological interest in relation to the mating systems of plants. The pollen production of fruit tree varieties is of practical value in relation to insect activity and the efficiency of varieties as pollinators.

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Leaf Lipids of Forage Grasses and Clovers

During the past five years, the lipids of forage grasses and clovers have been investigated in this laboratory. The results so far obtained have indicated the complexity of the lipids as well as the need for careful preservation and preparation of the samples.

The results of examination for lipid constituents of ten cocksfoot (*Dactylis glomerata*) samples collected at different periods may be summarized as follows:

	Total lipids	Lipids soluble in acetone at 0° C.: Total	Fatty acids	Unsaponifiable	Waxes	Phospholipids
Mean percentage on dry matter	6·12	5·06	3·13	0·96	0·86	0·20
Standard deviation	1·05	0·83	0·70	0·17	0·09	0·07

The fatty acids, comprising 2·15–4·03 per cent of the dry weight, were found by ester fractionation to have the following mean composition:

	Saturated: C_{14}	C_{16}	C_{18}	as C_{26}
Weight per cent	1·4	11·2	2·6	1·5

	Unsaturated: C_{14}	C_{16}	C_{18}
Weight per cent	0·4 (2·0 H)	6·4 (2·0 H)	76·5 (5·1 H)

Smith and Chibnall[1] deduced from bromination experiments that the unsaturated acids of cocksfoot consisted of approximately two thirds octadecadienoic acid and one third linolenic acid. In this work, however, the mean unsaturation of the C_{18} esters indicated approximately equal proportions of these two acids. In addition, dihydroxystearic acid (m.p. 131–132° and not depressed by admixture with authentic dihydroxystearic acid m.p. 132°) was prepared by oxidation of the acids from the C_{18} unsaturated methyl esters insoluble in acetone at −78° C., the yield corresponding to approximately 0·6 per cent oleic acid in the C_{18} unsaturated acids. By oxidation of a concentrate of C_{16} unsaturated acids, dihydroxypalmitic acid (m.p. 122–123°, m.p. 123–124° admixed with authentic dihydroxypalmitic acid m.p. 125°) was also prepared.

The low yield of phospholipids (0·1–0·3 per cent of the dry weight) found for cocksfoot (*Dactylis glomerata*) and for rye grass (*Lolium perenne*) preserved in cold alcohol or dried in a current of air at 35° or 70° C. is in agreement with the findings of previous workers[2]. Freshly-cut cocksfoot or rye-grass preserved by dropping into boiling alcohol contained, however, 1·5–1·7 per cent phospholipid. With boiling alcohol treatment the free fatty acid content of the lipids insoluble in acetone at 0° C., expressed as oleic acid, was 6–14 per cent as compared with the higher values of 30–37 per cent obtained by other treatments. In the case of white clover (*Trifolium repens*), similar high phospholipid values were obtained for samples preserved in boiling alcohol or dried in a current of air to 70° C.

The isolated phospholipids of cocksfoot, rye grass and clover contained usually *ca.* 2·0 per cent phosphorus. Relatively pure lecithin-cephalin fractions (P = 3·40 per cent, N = 1·4 per cent) amounting to 15 per cent of the total phospholipid were readily obtained. However, attempts to prepare pure lead phosphatidate, the crude preparations of which amounted to 10 per cent of the total phospholipid, were unsuccessful. Application of similar technique to rape phospholipids yielded without difficulty almost pure lead phosphatidate (P = 3·33 per cent, ash 32·5 per cent). The highest yields of the phospholipids were obtained by boiling the cold-acetone-insoluble lipids with ten volumes of acetone, cooling to 35° C. and decanting the waxes which remained in solution. The traces of phospholipid retained in the wax fraction were afterwards removed by crystallization from ether at − 20° C.

In general, the phospholipid fatty acid composition was found to resemble that of the corresponding glyceride, with the exception that the mean saturation of the C_{18} unsaturated acids tended to be lower (3·7–4·8 H) than in the case of the glycerides (5·0–5·3 H).

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Acetate Utilization for Maintenance of Motility of Bull Spermatozoa

The oxidation of acetate by mammalian tissue *in vitro* has been demonstrated; but comparatively little is known concerning the pathway of its oxidation or the possibility of its oxidation being coupled with phosphorylation. Recently Barcroft, McAnally and Phillipson[1] showed that acetate maintained the beat of the perfused rabbit's heart. Their demonstration suggests the ability of acetate to furnish energy for the maintenance of function in this tissue.

In view of their results, it seemed desirable to present data which have been obtained on the utilization of acetate by spermatozoa. It has been shown that washed, ejaculated bull spermatozoa suspended in phosphate-saline maintain their motility by the oxidation of intracellular phospholipids[2]. The addition of other metabolites to such sperm suspensions results in no further increase in respiration. If, however, the oxidation of the lipid is inhibited by 2,4-dinitrophenol, the utilization of various added metabolites may be readily demonstrated[3]. With epididymal spermatozoa the endogenous respiration is low and the effect of added metabolites is immediately shown. The effect of acetate on respiration and motility of both epididymal and of ejaculated

EFFECT OF ACETATE ON RESPIRATION AND MOTILITY OF BULL SPERMATOZOA.

Additions	Zo_2	Motility at 2 hours
Ejaculated spermatozoa :		
None	—25	++++
2,4-Dinitrophenol, 0·0001 *M*	—10	0
Acetate, 0·02 *M*	—23	++++
Acetate, plus 2,4-dinitrophenol	—28	+++
Pyruvate, 0·02 *M*	—26	++++
Pyruvate, plus 2,4-dinitrophenol	—30	+++
Epididymal spermatozoa :		
None	—7	+++
Acetate	—13	++++
Pyruvate	—16	++++

Zo_2 = c.mm. oxygen/10^8 cells/hour. Respiration was measured in the Warburg apparatus at 37° as described previously[4]. Specimens were removed from the Warburg flasks after 2 hours to observe motility.

spermatozoa treated with 2,4-dinitrophenol is shown in the accompanying table. For comparative purposes data for pyruvate are included for each type of spermatozoa listed in the table. Stimulation of respiration and prolongation of motility, by acetate, were obtained with certain collections of ejaculated spermatozoa by storing at room temperature until the intracellular reserves had been partially depleted. The utilization of acetate as well as of the intracellular lipid reserve[5] is completely inhibited by malonate. Evidence to be presented elsewhere indicates that the mechanism of lipid metabolism in the sperm follows a pathway similar to the *iso*citric acid cycle. Breusch[6] has recently claimed that citric acid is an intermediate in fat metabolism. The presence of an active aconitase in the enzyme preparations from spermatozoa produces an equilibrium of *iso*citric, *cis*-aconitic and citric acids and prevents the identifying of the primary condensation product. Acetate may enter such a cycle but the mechanism is as yet undetermined. It has been shown that acetate increases the respiration and supports motility of epididymal, and of 2,4-dinitrophenol-treated ejaculated spermatozoa of the bull. This work was supported by a grant from the National Committee on Maternal Health.

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Effect of Factors Influencing Mutability

UNSTABLE genes are found to be very suitable for the study of many factors influencing mutability, because high-mutability stock yields significant results for a number of flies examined much lower than with standard *ClB* method. In this study the influence of chemicals on germinal mutations of unstable gene *mt-3a* (*Drosophila virilis*)[1] was investigated. Altogether 79,011 flies were examined and 3,617 mutants found.

Flies raised on food containing 0·1 per cent copper sulphate or on food made alkaline (*p*H 9–14) by means of sodium hydroxide, or flies from eggs and larvæ treated with sodium hydroxide or ammonium hydroxide, show a highly significant *decrease* of mutability; this was found both in mass and in individual cultures; the effect applies also to genes the mutability of which is influenced by other genes.

The chemicals themselves probably could not penetrate[2] into the nuclei of the germ cells, and therefore the decrease of mutability must have been the general effect of *disturbances* in the organism. A similar decrease of mutability in unstable genes, as a result of temperature disturbances, has been also reported[3,4].

Since in 'stable' genes similar chemical treatments result in an opposite effect (increase)[5], I reach the following conclusion: when a given physical or chemical disturbance is able to change the mutability, the *change* will be an *increase* in 'stable' (wild) genes where the natural selection favours the lowest feasible mutability-rate[6] (close to optimum stability); whereas, it will be a *decrease* in 'unstable' genes the mutability of which is close to the highest feasible (optimum unstability).

I wish to express my thanks to Dr. M. Demerec, Carnegie Institution, Cold Spring Harbor, for his valuable suggestions in the course of this work.

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Physico-Chemical Nature of Bacteriolysis

WITHIN recent years, much attention has been paid to the antibacterial action of naturally occurring and synthetic products. The principal problem to be solved is that of the nature of the primary effect on the bacterial cell of the bacteriolytic or bacteriostatic agent. By such studies the intimate nature of the bacterial cytolysis may be illuminated and a practical means of early diagnosis of the lytic process may be forthcoming.

Hewitt[1] claims that visible lysis induced by the action of lysozyme is preceded by an activation of the bacterial dehydrases, this being shown by the fall in the aerobic redox potential of bacterial suspensions shortly after the addition of lysozyme. In support of this, Dr. Subkova in this Institute has shown that the oxygen uptake of bacteria (*M. lysodeikticus*) rises prior to the onset of lysis induced by lysozyme. No drift in redox potential occurs, however, when bacteriophage is added to bacterial suspensions.

Theoretical considerations led me to the opinion that the effects observed by Hewitt might be explained on the basis of the changes in *p*H occurring when lysozyme preparations (*p*H 7·2) are added to bacterial suspensions (*p*H 6·3–6·4). It can actually be shown that mere alkalinization of a bacterial suspension produces a negative potential drift, while acidification produces an opposite effect. By combining both kinds of procedure one may repeatedly

reproduce the course of the potential curve as pictured by Hewitt. Moreover, lysozyme inactivated by boiling causes the same change in redox potential as active lysozyme although no lysis occurs, and if the *p*H of the lysozyme is adjusted before addition to that of the bacterial suspension, no drift in redox potential occurs on mixing, though lysis takes place.

Since many of the most important properties of bacteria such as virulence, antigenic capacity, etc., reside in the surface layer, it was considered desirable to study the electrokinetic potential in relation to lysis. The experiments were made in collaboration with Dr. E. A. Moldavskaya, a Northrop microelectrophoretic chamber as modified by Abramson being utilized.

Preliminary experiments show that as soon as the lytic agent is added to a bacterial suspension, there is a sudden rise in the negative potential which persists for 5–10 minutes, after which the potential tends to return to the initial level. This phenomenon has been observed with lysozyme and in mixtures of *B. coli* and staphylococci with their respective phages. With *B. subtilis* the potential changes are in the opposite direction. The inactivated lytic agent does not produce any such effect, neither does the active agent affect the potential of quartz particles suspended in a similar medium. For bacteriophages the effect is specific.

The time relations of the potential changes are the same for lysozyme and bacteriophage. Since with lysozyme many of the cells are lysed instantly but with phage no detectable lysis occurs during the period occupied by the measurements, the possibility that the potential changes are produced by the adsorption of lytic products on to the surface of intact cells is eliminated. It may be concluded that the change in the potential of the bacterial surface accompanies lysis and is not due to an effect of contaminating impurities added with the lytic agent or to substances derived from lysed cells.

The study is being pursued in relation to bacteriostatic agents such as gramicidin and penicillin.

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Antibiotics and Competition

IN the attention rightly directed towards the very great practical potentialities of the bacteriostatics, which the researches of Prof. H. W. Florey and his collaborators have done so much to develop, the scientific interest of these as part of the mechanism of competition is in danger of being ignored.

It may well be that water-soluble antibiotics are of widespread occurrence as one of the factors concerned in the competition of both lower and higher organisms occupying the same substratum.

In an address to the British Ecological Society in 1929, I directed attention to the very marked check to the growth of the root systems of higher plants which could result from the presence of other species. Afterwards the Canadian botanist Pavlychenko, employing a team of workers, was able to obtain quantitative expression for this phenomenon, and showed that in cereals the effect of competition on root growth might bring about a reduction to less than 1 per cent of that when competition was absent.

S. C. Varma, working in my laboratory, produced evidence that the depression of root-growth in competition was due to soluble substances and that the effects of these varied with the species concerned[1]. The same investigator employing various species of Hypericum obtained striking evidence not only of the individuality of the relation between species but also of the modifying influence of soil reaction upon the effect of competition on root development[2].

The evidence that Prof. Florey has obtained respecting the sensitiveness of penicillin to acidity or alkalinity may perhaps indicate one way in which reaction of the substrate may exercise its profound effects, not only on bacteria but also on higher plants. There is the possibility that the soluble antibiotics from the root systems of higher plants may have their practical applications; but the object of this letter is primarily to direct attention to the importance which these studies on antibiotics may have in elucidating the more fundamental aspects of the competition problem, a realization of which might well result in the accretion of valuable data.

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[1] *Ann. Bot.*, N.S., 2, 203 (1938).
[2] Unpublished thesis.

Penicillin Dressings

Robinson and Wallace[1] have recently described a method of treating surface wounds with dressings of absorbent gauze inoculated with *Penicillium notatum*, the organism producing penicillin.

We have carried out preliminary experiments with a modification of this method, and the results (some two dozen cases have so far been treated) have been so astonishingly good that we feel wider tests are highly desirable. Large burnt areas covered with pus have cleared up in two or three days, and subsequent healing has been rapid.

Although the technique devised at the outset has given uniformly excellent results, further experiments are in hand to determine the optimum methods of production and application of the dressings.

We attach great importance to testing the bacteriostatic activity of each batch made, and to careful microbiological and clinical control throughout. With this proviso, the application of these dressings to superficial wounds appears to us to be free from risks; whether the method is suitable for deeper wounds is a matter for further research, and may present complications.

Dressings of the above type can quickly be prepared in large quantities, and at negligible cost.

Since one cannot predict how long will elapse before the industrial production of cheap, abundant and reliable penicillin, it appears to us that a fuller investigation of the 'live dressing' technique is a matter of the greatest urgency.

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GESTURE ORIGIN OF INDO-EUROPEAN LANGUAGES

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AMONG the many theories which in course of time have been propounded on the origin of language, that put forward by Sir Richard Paget in his work "Human Speech" (1930) is one which is most probable, and likely, to revolutionize philology. In this work he asserts that the speaking organs imitated the bodily gestures, especially those of the hands, with which *Homo sapiens* some 30,000 years ago tried to make himself comprehensible and to understand his neighbours. This theory was put forward first in a treatise on the Polynesian language by Dr. J. Rae in 1862 (reprinted in "Human Speech"). Sir Richard Paget emphasizes that the natural sign-language of those born deaf, and that of the Red Indians, may give useful information as to the stages by which the human language was developed. It is evident that if the gesture theory is right, a valuable aid may be rendered by the study of sign-language all over the world.

I have for many years been occupied with a study on the same problem, and the University of Reykjavik has just published my work on the subject: "Um frumtungu Indogermana og frumheimkynni: On the primitive speech of the Indo-European people and their first home". I had nearly completed my work when I read Sir Richard Paget's book, and had not seen his other book on the same subject: "This English" (1935). As my researches had led me in a surprising manner along the same paths as Sir Richard had trod, I feel impelled to record the main results of my own investigations. Of the 2,200 Indo-European roots constructed by philologists, the most important class can be explained as an imitation by the speech organs of the movements of the hands, as the first man began to speak; another class consists of roots imitating the sounds in Nature, the crying of animals, the whistling of the wind, the roaring of the sea, etc.; a third part, which is insignificant, is due to the spontaneous utterances of emotions, such as laughing, weeping, coughing, sneezing, etc.

On the basis of these fundamental conclusions, I have built up a system which embodies the labials, the dentals, the liquids and the gutturals. If the theory is correct, words beginning with labials ought to signify to babble, to keep, to retain and to destroy, if the lips are closed (for example, English flap, babble, blather; fat, fadge (= bundle); Lat. paciscor; O.E. beadu, "battle"; Lat. findo; English boat, bang, barrow). If the lips are open, the labials mean to emanate, to respire with noise (Greek πιμπρημι, πνεω; O.E. fnæsettan), and if the cheeks at the same time are puffed out, to inflate, to distend (Lat. pollex; English pat, bole, pit, bud, bold, etc.).

The roots beginning with dentals have a similar meaning, as the first man either pressed his teeth together, or let the tip of the tongue rest against them: to touch or retain (Lat. tango; English thrive, take), to destroy (English thwite (=cut chips), thong, tough, dingle, dangle), to extend and to draw (in this case the tongue has been drawn back from the teeth to the palate: Lat. tenere, ducere; English thin, tight, teem), and finally to shudder (if combined with *r*, which was originally cacuminal, hard and vibrating); English thread, thrave (=herd); Greek ἴρεω; Russian drožu, "shudder". In considering the consonants and the vowels combined, I have given a new explanation of the so-called "ablaut": the vowel *e* indicates originally an imitation of pointing at oneself (as *e* in Lat ego "I"), whereas *u* is the imitation of stretching out the hand to point at the other person (as *u* in Lat. tu, "thou"). The vowels *u* and *o* are similar and the variation of *e* and *o* (as seen especially in Greek) is to express what is present and absent in time and space. For that reason *e* is predominant in the present tense and *o* in the past. The vowel *i* means something little, as has already been shown by many philologists (Otto Jespersen and others). If *e* is combined with an *i*, the ablaut *ei* (comp. Greek ει) means something emanating from *e* (myself), which is significant for the first class of the strong verbs. A very great proportion of all strong verbs of the first class mean to remove from some one: Greek κιω; Lat. eo, ivi "to go"; English write, glide, etc. The "ablaut" $e + u$ is an oral imitation of a circulating movement, and therefore a great many of the second class of strong verbs signify something round, as Greek κῦμα, "sea"; English cudgel (from kuggila-), cog, kite (from kyte, "a round stomach"), cob, hoop, etc.

The consonant *s* is an imitation of sounds in Nature, such as the running of water, the howling of the sea, the whistling of the wind. Of 330 Indo-European roots beginning with *s*, 93 show the meaning: (1) to flow (of water) as sea, cinders, (O.E. sinder), stale, snite (= blow the nose), stream; Greek αἷμα (from saima, "blood"; Lat. serum; Serbian sipiti, "flows out"; Celtic sruaim, "stream", etc.; (2) to put in motion (of water or fluids) as Lat. salum "swelling sea"; O.E. séoðan (German sieden), Greek ῥόδος (from σρόδος) "waving sea", etc.; (3) to fetch up or drink: swell (German schlucken); (4) every sort of movement: to creep, glide, curve, turn, throw, shake, pull, contract, dangle, let fall: seal (German Seehund), snake, slide, sledge, slough, swipe, swim, shoot, scrag, shrimp, sparkle (O.E. spurnan, sow), sag, etc. The roots beginning with a guttural signify "to gape" (in the beginning "to open the mouth", to receive food) as chew, gag, Lat. hio, gustus, etc. The roots beginning with liquids (*r* or *l*) have varying meanings. The *r* roots especially signify to make noise (roar; Sanskrit rásati, "cries"; Greek ῥῆμα, "speech, word"), to put in movement (Lat. rabies, rota; English run, rise), to tear (English rot; O.E. rift; Lat. rima, rumpo), to stretch, to erect (reach, right, rank; Lat. rex, rogus). The imitation of the gestures of the hand is evident in the roots with *r*, which signify to erect: in those roots formed with $r +$ vowel (*e* or *i*, as *i* is a high vowel) + guttural the tongue is moved upwards to the palate. The roots beginning with *l* signify especially "to move, to withdraw" (lode, last; Lat. lira, comp. delīrus), to glide slowly (Lat. libo, liqueo; English liquid), to lie without movement (lie; Lat. lacus), to lick (Lat. labium; German lecken; O.E. liccian) and to play (little, lungs, light; Lat. lacertus, "arm"—the tongue plays against the palate).

After having examined the onomatopoetica (imitations of different cries of animals as birds, dogs, wolves, frogs, sheep, cats and pigs and those imitating every sort of noise), the total number of roots thus explained comes up to 500, or nearly a quarter of the whole material. Those 500 roots are the first basis of the Indo-European languages. They all have a concrete meaning, whereas most of the others are abstract. It is the object of further investigations

to show how the roots with concrete meaning have developed an abstract meaning. The aim of philology in the last hundred years has been to investigate every language of the Indo-European family and, of course, many others in order to collect a great store of words and compare them for the purpose of reconstructing the Pregermanic language as well as the Indo-European, to find out the laws, which at all times cause the changes of forms, meanings, etc. Philologists have been satisfied with massing together an immense store of knowledge. Philology must become a scientific study in the sense of Darwin's theory, and every group of languages in the world must be investigated on the same principles of evolution. I am convinced, having worked in philology for more than thirty years, that no explanation of the origin of languages is acceptable except the gesture theory, an imitation of the gestures of *Homo sapiens*, before he learned to employ his speech organs. The difficulties which arise in investigating languages such as Chinese, Japanese, etc., on these principles of imitations, are due to the fact that the change of form of a gestural word is usually the result of making the original gesture in a different manner. A long time must elapse before philology is led into these new paths. Philologists, like many others, have a fear of being thought unorthodox and prefer to walk on well-beaten paths.

BRITISH SOCIETY OF ANIMAL PRODUCTION

FOR many years there has flourished in the United States a Society of Animal Production, which has recently started to publish a full journal, the *Journal of Animal Science*. Similar societies have been formed in other countries, and on January 6, a corresponding British organization came into being. Much of the future organization of the Society was left to a provisional committee comprising Dr. John Hammond—who took the chair at the opening meeting—Prof. Wm. C. Miller, Prof. R. G. White, Dr. A. B. Fowler and Messrs. Alec Hobson, James Mackintosh and W. A. Stewart. Dr. J. E. Nichols, who had been responsible for most of the preliminary arrangements, was elected secretary-treasurer.

The opening meeting, held at the London School of Hygiene and Tropical Medicine, took the form of an all-day discussion on cattle-breeding policies, and the subject-matter was appropriately divided up into dairy cattle, dual-purpose cattle and beef cattle. In each section there was an opening paper, followed by a discussion.

Reading the paper on dairy cattle, Dr. Joseph Edwards compared present-day policies in Great Britain with the much more enterprising schemes in the United States. Artificial insemination is providing a real contribution to mass improvement schemes in the United States and, during 1943, the Artificial Insemination Society had arranged the servicing of 182,524 cows by 574 bulls. This is to be compared with the total of only 41,500 cows serviced by no fewer than 1,230 bulls in the co-operative Dairy Bull Associations. Dr. Edwards recently accompanied Mr. J. N. Ritchie, of the Ministry of Agriculture's veterinary service, on a survey of artificial insemination practices in the United States and would shortly submit with him a comprehensive report on the subject.

By whatever means the dairy farmer obtains improved stock, one point is fundamental, namely, that better breeding calls for better environment, if the improved genetic potentialities are to be exploited. It is noteworthy that most members of the American artificial insemination societies now feel that they have dairy cattle worthy of attention, and are demanding information on all up-to-date husbandry methods. It is desirable that the breed societies in Great Britain should play a much more important part in pedigree breeding than they are doing at present. In the United States, agreement between the dairy cattle breed societies has been attained on such matters as uniform rules for registration of cattle bred by artificial insemination and type-judging for all breeds. They also support research work destined to help them, for example, on the blood-typing parentage test, and they keep the bulk of pedigree records. In Great Britain, the élite dairy herds are a heritage and should be carefully protected against dispersal, besides being utilized for statistical research.

The paper on dual-purpose cattle was read by Mr. W. S. Mansfield, who stressed how animals of this type fit into mixed farming such as that practised by himself at the University Farm, Cambridge. In his own case, milk sales form the second largest item and yet are responsible for only one seventh of the total net sales, which are otherwise composed of returns from corn, potatoes, sugar beet, seed, mutton, pork, beef, horses and poultry. Cows on such a farm must be capable of (1) converting bulky by-products into milk; (2) making manure for the arable land; and (3) breeding heifer-calves worth rearing for the dairy and bull-calves worth rearing for beef. Such functions can be performed satisfactorily only by dual-purpose cattle.

Unfortunately, there is a dearth of dual-purpose cattle, and methods now adopted do not permit of breeding true. The only real solution is to practise inbreeding or long-continued line-breeding. Careful management of dual-purpose heifers is most important: it is almost impossible to do the heifer calves too well for the first six months of life, because, if they are then transferred to a much lower plane of nutrition, they will continue to grow well for another eighteen months, will be ready to mate at twenty months, and at calving will be as large as heifers six to nine months older that have been fed inadequately as calves.

Mr. W. A. Stewart, reading the paper on beef cattle, dealt first with sources of supply, and stressed that, on lowland farms, it is most uneconomical to rear only one calf per cow. Among methods of multiple rearing, there is that practised during the first half of the nineteenth century by Hugh Watson, of Aberdeen Angus fame; but there is also Mr. H. R. Overman's system, namely, bulling a certain number of heifers, selling the greater number when freshly calved, and rearing all the calves on those remaining.

Ley farming is likely to have beneficial effects upon the numbers and quality of beef cattle that could be fattened in certain areas, for example, the Welland Valley, where formerly graziers required old bullocks for the pastures but in future would be able to fatten younger cattle.

It is essential that the milk-producing qualities of British beef-breed cows should be increased. This can best be done by making full use of bulls that are proved 'getters', not only of offspring of a high standard of beef conformation and maturity, but also

of daughters that are good milkers. It is not impossible to aim at 300–400-gallon lactations even among cows of high-class beef type.

The Argentine markets have been responsible for the appearance in sale- and show-rings of a small, thick, fine-quality, fine-boned, short-legged type of animal. This is not necessarily the type desired by the average British farmer, and it is likely that a middle course will be adopted, and that animals will be produced which give reasonable weight for age but are early maturing. ALASTAIR N. WORDEN.

PLYWOOD ADHESIVES AND LININGS

ATTENTION has already been directed in NATURE to the important research work carried out in the Forest Research Institute, Dehra Dun, India, in connexion with the construction of plywood containers to replace metal drums and other containers imported in large quantities before the War, the incidence of the latter bringing this source of supply to an end. In connexion with this research, investigations had to be instituted into possible new adhesives. The Wood Preservation Section of the Institute has done important work on the development of maize and ground-nut proteins as adhesives, and on various lining compounds for proofing plywood containers and drums. The plywood and other industries have been affected by the shortage and high prices of casein, and this work on the protein of maize, which is a waste product of starch manufacture, will not only enable this waste product to be used but also will give an adhesive at a competitive price.

Two Indian Forest Leaflets (Utilization), Nos. 40 and 52 (For. Res. Inst., Dehra Dun, 1943), deal with plywood adhesives. In Leaflet No. 40 (Pp. ii+14. 9*d.*) the result of research has shown that prolamins, isolated from Indian cereals, are equally suitable for the preparation of water-resistant plywood adhesives. This type of adhesive can be prepared by adding to a 20 per cent suspension of prolamin in 80 per cent alcohol, 5 per cent of formaldehyde (40 per cent formalin). One per cent of ammonia or an organic acid such as acetic, tannic, etc., may be added as a catalyst. The adhesive suspension so prepared should be applied within twenty-four hours of its preparation. Veneers coated with these adhesives, after drying at room temperature, should be pressed together at a temperature of 250–300° F. for a suitable period (10 minutes for 3/16 in. plywood) at a pressure of 200 lb. per sq. in.

Leaflet No. 52 (Pp. ii+6. 5*d.*) deals with researches with the object of utilizing the wholemeal and proteins of sunn-hemp seed (*Crotolaria juncia*) for plywood adhesives. For commercial plywood (not requiring a high degree of water resistance) a wholemeal lime silicate formula with rosin, copper sulphate and tannic acid has been found suitable. With the protein, lime silicate and borax-formaldehyde formulæ have been found suitable for the preparation of water-resistant plywood.

Leaflet No. 49 (Pp. ii+10. 5*d.*) discusses the results of experiments on various types of inner linings suitable for plywood containers for storage of various commodities such as greases, liquids and so forth. A variety of inner coatings have been tried and tested; some were found good for certain materials, others for other contents, but a universal leak-proof coating has not yet proved attainable. The requirements demanded by such a lining are nearly as variable as the nature of the commodities themselves. The linings so far tried, nine in number, are: animal glue-treacle composition, prolamin formaldehyde glue, casein or vegetable protein-formaldehyde glue, paraffin wax, bituminous paint, shellac varnish, shellac-melamine composition, phenol-formaldehyde resin and cashew shell oil varnish. The methods of preparation and application of these linings are described in the leaflet.

LOCATING BURIED CABLES ELECTRICALLY

FOR the protection of buried inter-city cables against damage by lightning, it is sometimes necessary to install copper shield wires above a cable already in the ground, and the precise route of the cable must be determined so that the shield wires can be correctly placed. It is also important to know the depth of the cable, so that damage to it may be avoided while installing the shield wires. This can now be done electrically with a simple device which consists of coils that pick up a tone which has been applied to the cable sheath. The device is described in an article by R. M. C. Greenidge (*Bell Lab. Rec.*, 22, No. 3; November 1943).

The device carries three coils, a fixed locating coil A, a fixed direction coil B and a pivoted depth coil C mounted on a crossbar attached to a vertical rod which supports a graduated quadrant scale S and has a spirit-level on its upper end. A handle is used to adjust the apparatus by forcing a spike into the ground. A selector switch connects any one of the three coils to an amplifier and detector circuit, which is multiple connected to the coil circuits. A pointer P indicates the setting of the depth coil C, and a shaft which slides vertically permits levelling the apparatus.

The test current is generated by the buzzer of a 20C. test set. One of its terminals is connected to the cable sheath at a pressure-testing valve and the other to an earth rod located 50–100 ft. from the cable. Current flows along the sheath in both directions, and through earth to the earth rod. With the amplifier in operation and earphones used as detector, the selector switch is set to close the locating coil circuit and the apparatus is carried across the path of the cable. When coil A comes directly over the cable, a null position is reached, and at this point the spike is pushed into the ground. By setting the selector switch to close coil B circuit and rotating the apparatus round the spike, the null point of coil B is found. In this position the horizontal bar on which coil C is located is at right angles to the path of the cable. Adjusting the sliding shaft then levels the device, after which the selector switch is set to close coil C circuit and the depth coil rotated on its pivot for the null point. The reading on the scale, as indicated by the pointer, is the distance of the centre of the cable below the surface. If r is the radius of the cable, h the height of the coils above the ground, l the distance between the coils A and C, and d the depth of the cable, $d = l \cot \theta - k$, where $k = r + h$ and θ is the angle which the pointer P makes with the horizontal when coil C is in its null position. By this formula the quadrant scale S can be calibrated for depth.

The depth indicator is usually handled by a team

of three men. Where the cable is buried to a depth of 25 in. or more, measurements are taken every 50 ft. and flags are placed to mark the path of the cable. As a check on the accuracy of the survey and also of the guiding of the tractor and plough used for laying the shield wires, test holes are dug at intervals to expose the wires and cable after the plough has passed. In most cases the two wires are found to straddle the cable almost exactly and are about 4 in. distant on each side, but in some instances they are off centre by 2–3 in. As a result of the depth survey and the precautions during the ploughing, damage to the cable is completely avoided.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Saturday, February 5

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10.30 a.m.—Conference on "Budgetary and Dietary Surveys of Families and Individuals", Part 1.

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Sir Edmund O. Teale: "The Geology and Scenery of Tanganyika Territory, East Africa".

INSTITUTE of PHYSICS (MANCHESTER AND DISTRICT BRANCH) (at the Christie Hospital and Holt Radium Institute, Wilmslow Road, Withington, Manchester), at 2.30 p.m.—Prof. W. V. Mayneord: "Physical Principles of X-Ray Therapy".

Monday, February 7

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Sir Robert Reid: "The Excluded Areas of Assam".

Tuesday, February 8

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. Werner Kissling: "Eriskay" (Sound Film).

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. J. Arthur Reavell: "Infra-Red Radiation and its relation to Distillation and Evaporation Problems".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. D. Kay: "Modern Developments in Dairy Science", iii. "Problems of Milk Distribution and Manufacture".*

INSTITUTION OF CIVIL ENGINEERS (STRUCTURAL AND BUILDING ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. W. E. J. Budgen: "Modern Computation Methods and Office Practice in the Design of Statically Indeterminate Structures".

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. H. W. Lee and Miss E. A. Neumann: "Surface Treatment of Lenses".

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Sir A. Stanley Angwin: "Recent Progress in Telecommunications due to the use of New Materials".

Wednesday, February 9

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Miss E. Strudwick: "Education To-day and To-morrow", 4: "Secondary Schools for Girls".

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Rodent Infestation" (to be opened by Mr. W. McCauley Gracie).

SOCIETY OF CHEMICAL INDUSTRY (NUTRITION PANEL OF THE FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. F. A. Robinson: "The Vitamin B_2 Complex—Some Recently Characterised Components".

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m.—Mr. B. L. Metcalf: "Transmission and Distribution of Electricity to Mines".

Thursday, February 10

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "The Strategy and Tactics of Crystal Structure Analysis by X-Rays".*

KING'S COLLEGE (in the Department of Electrical Engineering, Strand, London, W.C.2), at 3 p.m.—Mr. W. D. Horsley: "Turbo Generator Practice".*

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Prof. J. D. Cockcroft, F.R.S.: "Cyclotron and Betatron".

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. H. Barron, Mr. J. N. Dean and Mr. T. R. Scott: "Thermoplastic Cables".

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. E. T. Jones: "Flight Testing Methods".

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 7 p.m.—Dr. A. J. Ewins, F.R.S.: "Progress and Problems of Chemotherapy" (Harrison Memorial Lecture).

Friday, February 11

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. G. Ingle Finch, F.R.S.: "Wear of Surfaces and Lubrication".*

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Annual General Meeting. Discussion on "The Mathematical Needs of the Physicist" (to be opened by Prof H. Levy).

Saturday, February 12

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 2.30 p.m.—Dr. G Jessop: "Some Electro-chemical Methods of Analysis".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AGRICULTURAL ASSISTANT to the Agricultural and Horticultural Organizer—The Clerk to the County Council, Shire Hall, Bedford (February 11).

MASTER to teach mainly MECHANICS in the Junior Technical School of Coventry Technical College—The Director of Education, Education Offices, Coventry (February 11).

GRADUATE TEACHER (full-time, temporary) OF ENGINEERING SUBJECTS—The Principal, Twickenham Technical College, Egerton Road, Twickenham, Middlesex (February 12).

ASSISTANT MASTER (full-time, graduate) qualified to take GENERAL ENGINEERING SUBJECTS in the Junior Technical School and MECHANICAL ENGINEERING SUBJECTS up to Ordinary and Higher National Certificate standard in the College senior part-time courses—The Principal, Southall Technical College, Beaconsfield Road, Southall, Middlesex (February 12).

ASSISTANT LECTURER IN PHYSICS—The Registrar, University College, Nottingham (February 12).

HEAD MASTER—The Clerk to the Governors, Sir Joseph Williamson's Mathematical School, 116 High Street, Rochester (February 12).

DEPUTY BOROUGH ENGINEER AND SURVEYOR—The Town Clerk, Town Hall, Ilford (endorsed 'Deputy Borough Engineer') (February 15).

SPEECH THERAPIST—The Chief Education Officer, County Offices, Chelmsford, Essex (February 15).

GRADUATE TEACHER (temporary) OF SCIENCE OR MATHEMATICS, and a TEACHER (temporary) OF ENGINEERING SUBJECTS—The Principal, Luton Technical College, Park Square, Luton, Beds. (February 15).

BIO-CHEMIST—The Medical Officer of Health, 68 St. Giles' Street, Norwich (February 16).

ASSISTANT LECTURER AND DEMONSTRATOR IN CHEMISTRY—The Registrar, University College, Leicester (February 21).

PRINCIPAL of the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton 1 (February 21).

LABORATORY ASSISTANT IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Springfield, Sidgwick Avenue, Cambridge (February 26).

LECTURER (man or woman) in the DEPARTMENT OF GEOGRAPHY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (March 1).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

COLLIERY SURVEYOR for the Nigerian Government Collieries—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W C.2 (quoting Order No. O.S.20).

MINE MANAGER and ASSISTANT MANAGER for an underground Chrome Mine in New Caledonia (South Pacific)—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Order No. O.S.17).

LECTURER IN THE DEPARTMENT OF OCEANOGRAPHY—The Registrar, The University, Liverpool 3.

LECTURER (full-time) OF MATHEMATICS AND SCIENCE at three Boys' Junior Technical Schools—The Director of Education, Education Offices, 14 Sir Thomas Street, Liverpool 1.

LECTURER (full-time) IN MECHANICAL ENGINEERING to teach to Higher National Certificate standard—The Principal, Wimbledon Technical College, Gladstone Road, London, S.W.19.

MASTER FOR ENGINEERING WORKSHOP PROCESSES AND PRACTICE—The Principal, County Secondary School and Cumberland Technical College, Workington.

GRADUATE ASSISTANT to teach MATHEMATICS AND SCIENCE, a GRADUATE ASSISTANT FOR JUNIOR ENGINEERING SUBJECTS in Technical Day School and ordinary National Certificate Subjects in MECHANICAL ENGINEERING in Technical College, and a GRADUATE ASSISTANT for Subjects up to Higher National Certificate standard in MECHANICAL ENGINEERING and be able to teach ELECTRICAL ENGINEERING up to ordinary National Certificate standard—The Chief Education Officer, Education Offices, West Hartlepool.

PHARMACIST FOR THE GOVERNMENT OF NORTHERN RHODESIA HEALTH DEPARTMENT—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1252).

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THE ROYAL OBSERVATORY

THE announcement in the daily Press that the Admiralty has decided, in principle, that the Royal Observatory shall be moved from Greenwich to a new site, where conditions are more favourable for astronomical observations, will not have come as a surprise to those who have watched the trend of events in recent years. Rather is it a matter for surprise that the Observatory has been able to carry on for so long, under conditions of increasing difficulty, on its original site. Many observatories elsewhere have been compelled by similar circumstances to move. In the case of the Royal Observatory, the long associations with Greenwich, the advantages in fundamental astronomy of continuity of observation on the same site and with the same instruments, and its position on the prime meridian, have no doubt all played a part in postponing a decision the ultimate inevitability of which must long have been apparent.

The Royal Observatory was founded in 1675 by Charles II, to meet the needs of navigation. The problem of finding longitude at sea had then become urgent. The positions of the moon and stars were not known with sufficient accuracy to enable the method of lunar distances to be used. The Royal Warrant for the building of the Observatory states that "in order to the finding out of the longitude of places for perfecting navigation and astronomy, we have resolved to build a small Observatory within our park at Greenwich, upon the highest ground, at or near the place where the Castle stood". Sir Christopher Wren was appointed as architect and the Rev. John Flamsteed was appointed "our astronomical observator" and directed "to apply himself with the most exact care and diligence to the rectifying the tables of the motions of the heavens, and the places of the fixed stars, so as to find out the so-much-desired longitudes of places for the perfecting the art of navigation".

This branch of astronomy has continued to be the fundamental work of the Observatory throughout its long history. It provides the foundations upon which so much astronomy is built. The importance of the contribution made by Greenwich was stressed by the eminent American astronomer, Simon Newcomb :

"The most useful branch of astronomy has hitherto been that which, treating of the positions and motions of the heavenly bodies, is practically applied to the geographical positions on land and at sea. The Greenwich Observatory has . . . been so far the largest contributor in this direction as to give rise to the remark that, if this branch of astronomy were entirely lost, it could be reconstructed from the Greenwich observations alone."

When the need had arisen for general agreement about the choice of a zero or prime meridian from which longitudes should be measured, and a conference was called in Washington in 1883 by the State Department of the United States to consider the question, no alternative to the meridian through Greenwich was seriously considered. By an almost unanimous vote, the meridian through the centre of

the transit instrument of the Greenwich Observatory was adopted as the prime meridian and as the basis for a zone time system. The choice of Greenwich was due to the close concern of the Observatory for more than two centuries with the practical needs of navigation.

The work of the Royal Observatory has not, however, been restricted to fundamental astronomy. In Airy's time meteorological, magnetic, solar and spectroscopic observations were added. Meteorological and magnetic observations were commenced in 1840. The Royal Observatory has the longest continuous series of magnetic observations and was the first observatory to employ photography, in order to obtain continuous records of the variations of the earth's magnetism. The magnetic observations were removed from Greenwich to Abinger, in Surrey, in 1923, consequent upon the electrification of the suburban system of the Southern Railway. The Solar Department, added in 1873, was a natural development arising out of the discovery that there were certain definite relationships between terrestrial magnetism and phenomena on the sun. In 1886, the 28-in. refractor was added to the Observatory's equipment, for visual spectroscopic observations and for double-star measurements. The application of photography to astronomy opened many new fields of work, and the Royal Observatory has taken a prominent part in the work of the Astrographic Catalogue, in the measurement of stellar parallaxes, in the determination of magnitudes and proper-motions of stars, in the measurement of colour temperatures and in other important investigations. A 26-in. photographic refractor, a 30-in. reflector and a 36-in. reflector have been added to the equipment of the Observatory at various times.

When the Royal Observatory was built, Greenwich was a fashionable village in the country, several miles from London. It was many years before the outward growth of London, with its accompanying pall of smoke, began to be troublesome. In 1824 Pond, then Astronomer Royal, erected an azimuth mark at Chingford for the new Troughton transit instrument. It must have been possible at that time to observe this mark with fair regularity; but it is many years since it has been visible from Greenwich even under the best conditions. The first note of concern about the future appears in the report of the Astronomer Royal (Sir William Christie) to the Board of Visitors of the Royal Observatory in 1906: "The continued efficiency of the Observatory is seriously threatened by the schemes for generating stations planted, or to be planted, in the immediate neighbourhood of the Observatory." The London County Council was then building a generating station exactly on the Greenwich meridian, half a mile from the Observatory and overshadowing the noble buildings of the Royal Naval College. That a public authority should have been allowed to commit such an act of vandalism is a reproach to the nation. The two chimneys, which stride the meridian, were indeed truncated to reduce the interference from smoke and heated gases with observations of circumpolar stars below the pole. Nevertheless, this generating station has been a source of continual trouble, discharging smoke and fumes and, with a northerly wind, showering grit over the Observatory, which has caused damage to pivots and other delicate parts of the instruments.

At the close of the War of 1914–18, there were still green fields and country lanes within an easy walk of Greenwich in the south-east direction. But since then London has stretched its tentacles well beyond Greenwich and, during the same period, there has been considerable industrial development in the vicinity of the River Thames. The deterioration of conditions for observation during the past twenty-five years has been marked and progressive, and has been referred to in the annual report of the Astronomer Royal on several occasions. The measurement with an Owens automatic filter of the pollution of the atmosphere by solid matter was commenced in 1934 and has shown that the pollution at Greenwich is not surpassed, on the average, at any reporting station in Great Britain. The difficulties were summarized in the Astronomer Royal's report for the year 1939.

The progressive decrease in the transparency of the atmosphere at Greenwich is shown by comparison between the Greenwich and Kew annual sunshine totals. From 1911 until 1920, Greenwich averaged sixty-four hours more sunshine than Kew; thereafter there was a rapid relative decrease in the Greenwich totals, so that during 1936–38 Kew averaged 159 hours more than Greenwich. This decrease in the amount of sunshine recorded at Greenwich in relation to the amount recorded at Kew is the result of loss of register at Greenwich when the sun is low, caused by atmospheric impurity.

A further trouble, first referred to in the report of the Astronomer Royal for 1937, was the brightness of the sky resulting from scattering of light from street lamps and illuminated advertisement signs; modern developments in street lighting, such as mercury vapour lamps and high-pressure gas, to meet insistent demands for better road illumination, have made the night sky at Greenwich (in peace-time) so bright that the Milky Way is never visible with the naked eye and long-exposure photography has become impossible. All types of observation, both visual and photographic, have been adversely affected; some, such as photometric observations, which require uniform transparency of the sky in different directions, can no longer be undertaken. New types of instrument, such as the Schmidt camera for the photography of faint stars, cannot be used at Greenwich because of the fogging of the plates.

It should not be necessary for a scientific establishment—even though it is the oldest in Great Britain—to stand out against public amenities. The astronomer requires a dark sky and a clean atmosphere; the public wants well-lit roads and puts up with a polluted atmosphere as the penalty of urbanization. The staff of the Royal Observatory has for many years been waging an unequal and losing struggle against progressively worsening conditions. It is not right that the reputation and prestige of the Royal Observatory should suffer by having to turn back

from the van of progress in astronomy. The contributions that the Observatory has made to astronomical and nautical science in its long history, and the prestige that it has brought to the British nation, give it a right to ask for a new and a worthy home, where it will be free from the troubles that have so sorely beset it and where it may enter upon a new era of service to the community and of scientific achievement.

The Paris Observatory, faced with somewhat similar problems in a much less acute form, set up its large telescopes at Meudon and established a high-altitude station at the Pic du Midi. The possibility of keeping the meridian work and the time service at Greenwich and moving the rest of the work has evidently been considered and rejected. The meridian observations are handicapped and their accuracy is impaired by the difficulty of observing low north stars. The long-range programmes of observation, which should be undertaken by a great national observatory, require every member of the staff to observe, usually with more than one instrument; division into two branches would entail a serious loss of flexibility. The Observatory need not necessarily be tied to the prime meridian, which has been fixed by international agreement and will remain. The War has already necessitated the removal of the time service from Greenwich, and Greenwich time is now being provided by two time stations, neither of which is on the Greenwich meridian.

It is to be hoped that the original building, which Wren said that he built "a little for pompe", and the old buildings clustered around it will remain and that the historic instruments—including Halley's, Bradley's and Pond's transits, Bradley's zenith sector, with which aberration and nutation were discovered, the old quadrants, and, most famous perhaps of them all, the Airy transit circle—will be suitably displayed in them. They will become an object of pilgrimage not merely to astronomers but also to many visitors to Great Britain from all parts of the world.

Much of the work of the Royal Observatory has had to be removed elsewhere during the War, either for reasons of security or because of enemy action. The continuity of many programmes of observation has been broken. It is to be hoped that a new home will be made available as soon as conditions permit, so that the various branches of the Observatory can be brought together again and normal work resumed under more favourable conditions. It is understood that Treasury sanction will be required; but surely in a case such as this, to obtain it will be little more than a formality. The new home should be one befitting the long history and great traditions of the Royal Observatory. What could be more appropriate than that one of our large historic country houses, mellowed with age and rich in associations with the past, should form the nucleus of the new Observatory, the various telescopes being erected in the surrounding grounds? A fundamental need is for a neighbourhood not likely to be affected by the spread of industry, and it should not be impossible to find such a site.

A TURNING POINT IN EDUCATION

Education in Transition

A Sociological Study of the Impact of War on English Education, 1939–1943. By H. C. Dent. (International Library of Sociology and Social Reconstruction.) Pp. xi+244. (London: Kegan Paul and Co., Ltd., 1944.) 12*s.* 6*d.* net.

THE Education Bill now before Parliament is remarkable in many ways. The complete break it effects with the traditions of a century is enough to justify a description of it as revolutionary. Yet support for it is well-nigh unanimous, and criticisms offered during the second reading debate were confined to relatively minor points.

What is most remarkable about all this is that it should have been possible to introduce such a Bill at all, let alone to do so amid such general approval. It would have been inconceivable even as recently as three years ago.

Evidently some profoundly important change of outlook has occurred in Great Britain within a very short time. The new sense of educational needs is obviously a result of this deeper and wider change. It might well have happened eventually without the shock of total war. But the shock has certainly accelerated it and given it both sharper definition and, for the time being at least, a powerful backing of national conviction.

Essentially the change is towards a new conception of national destiny both in internal life and in external relations and responsibilities. It is British society as a whole which now tends to think so differently of itself. That the changed outlook should find expression first and most prominently in a liberally inspired plan of educational reconstruction is both natural and significant. The quickened sense of destiny and new life comes to its logical focus there, and Mr. Dent is well justified in the suggestion he offers in the subtitle of his book.

What is needed then, at such a turning point, is a backward glance with a critical eye over the past four years to mark out the route we have travelled. Mr. Dent is very favourably placed and unusually well qualified to perform this service, and he has discharged it with grasp and understanding in a timely and competent book. Though he writes with both warmth and insight he shows no tendency to dramatize the story. Yet the material itself is so intensely dramatic, passing as it does from the nerveless and sluggish Britain of the last decade to the sinewy and expectant Britain of to-day, that, in effect, it dramatizes itself.

The author tells his story in four stages, beginning with the mass-evacuation of children upon the outbreak of war. These are: disintegration, recuperation, adaptation and ferment. How strongly this suggests a five-act play of which the final act is still to be played! One could wish that something of this sense of drama on the great national scale might be communicated to those numerous critics of the Education Bill who see in it not at all the earnest of a great awakening but merely a failure to give full effect to some petty or short-sighted interest of their own.

Disintegration is, of course, the story of the disastrous consequences of hasty and ill-planned evacuation, planned it would seem by those who had little or no concern for educational consequences but were only eager to get the children away from the danger-

areas. Yet this very bungling contributed in a most effective way to the awakening that was to take place. As Mr. Dent very truly observes: "It was a striking illustration of the sociological rule that the significance of an institution of society only becomes appreciated in a marginal situation".

The "it" here is the effect of evacuation in setting so many people thinking seriously about national education for the first time in their lives; the "marginal situation" is the shock of close contact between sections and classes of the population which had hitherto been almost totally ignorant of one another. Much was to happen as the result of this, the redeeming effect of what was otherwise so nearly disaster.

Recuperation followed through efforts from two main sources. One was the devoted work of an army of teachers and officials. To these Mr. Dent does ample justice. He does rather less than justice to the other, to the Board of Education itself. No doubt the Board, like so many other authorities, was lacking in grasp and foresight at the outset. But it had no free hand and was constantly being pushed aside or over-ruled. It is probably no accident that recuperation proceeded *pari passu* with recovery by the Board of its own proper controls and responsibilities.

Adaptation is a longer story. It became possible in the respite that was accorded us in 1941. The point that Mr. Dent makes with much force here amply justifies the title of the story. After mentioning the headings of the developments that occurred: war-time nurseries, school-meals, camp boarding schools, service of youth, pre-service training, youth registration, and several others, he comments: "Not a single one of these developments is wholly new. Powerful as has been the stimulus which total war has given to educational thought in this country, in the realm of educational practice it has as yet brought into being no absolutely new form or institution", though he believes that in the realm of theory we are now reaching new territory. The observation is just. What was working at this stage was the characteristic English 'hunch', inchoate thought revealing itself first in improvising action.

Then, very fruitfully, and again quite characteristically, follows the ferment, which has been going on so vigorously for the last year or two, expressing itself in a flood of books, pamphlets, brochures, articles and other forms of declaration. Mr. Dent gives an able analysis of this material, showing conclusively how the thinking, while almost invariably quite practical, was all the time deepening and widening and establishing ever firmer grasp.

So, in effect, the essential revolution had already taken place when the Board, seizing the happy moment, issued first its White Paper and then its draft Bill.

The full moral of the story has yet to be drawn. One important aspect of it is well stated by the Archbishop of Canterbury in a passage that Mr. Dent quotes: "The educational problem must never be separated from the social problem. It is all part of the great enterprise of civilization—the provision of a truly civilized society". But, as Mr. Dent so clearly sees, it is for the British people themselves to draw the full moral. The moment is big with fate. The Bill at its best, even when it has become an Act, offers no more than a great opportunity. We still have to learn new restraints and to subordinate the lesser to the larger interests if we are to make full and fruitful use of the instruments it places in our hands. FRED CLARKE.

SOCIAL PSYCHOLOGY IN A WAR FACTORY

War Factory

A Report by Mass Observation. Pp. 127. (London: Victor Gollancz, Ltd., 1943.) 4*s*. 6*d*. net.

WHAT'S in a name? More now than in Shakespeare's time. To attract notice, a label is necessary for any new movement, yet its later directions may be inaccurately described by the original title. It might shock some gentle English socialists to realize why there is a 'z' in Nazi, or organizers of O.C.T.U.s to discover an early meaning of 'cad'.

"War Factory" is "a Report by Mass Observation". Yet it is not by the masses, and Mr. J. B. Priestley would deny that it is of the masses. Perhaps because of this, it reads unusually well. Here is a workmanlike account of 'functional penetration' or 'participant observation'. This technique anticipated Mass Observation; a fact acknowledged with some back-hand swipes by Mr. Tom Harrisson in an interesting, splenetic preface. He shows gratifying signs of dropping a tiresome tendency to quote only work by the 'old firm'; yet it is still true that science, like a house, is built by superimposing stories, not by ballet-leaps deriving momentum from kicks at the work of predecessors. Mass Observation has still to work itself into the corpus of science. In this attempt, spinosity of style will accomplish merely punctate, superficial penetration.

"War Factory" is well written by a mother; a Cambridge graduate, less ambivalent towards social differences than many educated authors, with an ear almost untitillated by odd dialect and bad language. Any temptation to dazzle the B-class—as market-researchers put it—has been resisted.

The observations were made unobtrusively while the author worked in a small factory. Here only two managers knew that the workers (and themselves) were being studied. Part of the factory was an altered private house, situated neither in a large town nor in the north of England. It is hoped that the politically minded, on reading this, will not decide that the book can therefore be neglected; even these workers are God's creatures; and in the country, geographical and social differences significantly affect workers' attitudes.

Most of the employees described are young country girls with no industrial tradition, 'directed' to a new, chimneyless and socially 'rootless' factory. Character-sketches are given; they are salutary reading for machine-worshippers who ignore individual mental differences, though subject to the methodological criticism that such novelistic or journalistic efforts may cast as much psychological light upon the writer as upon the person described. Even in this little congeries—apparently it never grew into a community—there was marked social stratification. Girls in the machine and the assembly shops were regarded in very different lights. Nearly all, however, spoke of those who gave orders and did domestic work as 'they': and those who obeyed and were cared for solicitously as 'we'; a sobering thought for democrats.

The investigation was paid for by the firm observed; unlike the studies reported in "The Pub and the Public". This fact must be taken into account in appraising the result. The observer's criticism, however, was accepted sportingly and broadmindedly,

in a constructive spirit. Indeed, the footnotes, by the works and labour managers, sometimes re-interpreting the writer's findings, but usually agreeing with them and accepting their practical implications, are some of the most encouraging parts of this book. Has the admirable "Western Electric attitude", which regards differences between the personality and temperament of workers, even in engineering shops, as suggesting scientific problems, spread at last from the United States to England ? North of the Trent we await the dawn.

In this book there are no Zolaesque revelations, no 'front-page' stuff. Some newspaper men will be disappointed in this factory, for no men bite dogs. It offers no foundation for a glossy propaganda film or husky radio-postscript. We find just a detailed account of how a bunch of country girls worked, or didn't, in this comfortable, rather pleasant war-factory; how they adapted themselves, or didn't, to the bench and the hostel; how they solved the 'academic' problem of rest-pauses by just taking them when 'so disposed'; how they displayed almost no interest in the War, except to speculate what they would do when it was over, thus puzzling tidy-minded 'scientific' thinkers, who regard the War as 'a stimulus', like a spur or a tot of rum. Now, this attitude will annoy people who, having delighted to design or make those lovely machines, cannot understand why girls should fail to play with them as enthusiastically, nine hours a day, for years. Yet why should they delight for ever merely in fiddling with bits and pieces, the function of which (often for necessary reasons) was unknown to them ? In peace-time, some of these girls would have been occupied, in sunshine and fresh air, with chickens, calves, even with their children. It is not recorded that they had been guided, by tests and psychological interviews, to different jobs, with some respect paid to their idiosyncrasies, as they would have been had they joined the Forces. Nor do we read of courses arranged by an Army Bureau of Current Affairs, or discussions in the British Way and Purpose. Yet incentive and motive are complex affairs, not easily to be packed into a pay-envelope.

The physical circumstances of the work seem to have been admirable. Though hours were long, the work was easy. There was good food, at which the amount of grumbling seems inversely related to the workers' degree of education and sophistication. Though some girls disliked being billeted upon inhospitable landladies, others were installed in an excellent hostel. But—and for the social psychologist this is perhaps the most interesting fact—in order that they might perform, as often as possible, a series of (to them) almost meaningless actions, everything else was done for them. They had no part nor lot in worries about food-rations or shopping; sometimes on returning home they found that their family had ceased to consult them even about important matters like taking a lodger. When the day's work was over, often they did nothing but have supper and go to bed. They seldom listened to the radio, or read a newspaper, and when an illustrated daily paper came their way, they thumbed it listlessly, chattering about astrology, fashions and dress coupons. When they gossiped it was usually not about others in the factory but about people at the real place : home. They regarded the War as something to be endured, like a very heavy shower of rain, which for some inscrutable reason has not stopped, cannot go on for ever and cannot be affected by their efforts. Even grumbles were seldom directed towards anyone who could remedy the fault.

Yet it should be remembered that for them there were no smart uniforms, presumably no badge to show that they were doing important war work, no glamour, no public parades. The town into which they were herded did not want them, showing this positively and negatively ; for example, when the firm suggested the establishment of a British Restaurant there was no effective local co-operation. For their sisters, the Armed Forces may have provided many things of which these workers were deprived, including a stimulation of the intellect and discussion of their future as citizens and voters. In the life of these young workers, there is a background of aimlessness, irresponsibility and boredom ; all regarded as inevitable. This study, in conjunction with other field-work, emphasizes the decline in positive citizenship among such young people. The *laisser-faire* of leisure and its dangerous separation from work are immediately and primarily responsible for this. Here, under its modern orchestration, the social psychologist's ear discerns an old, mournful tune.

T. H. PEAR.

RECOGNITION OF THE STARS

Star Recognition

By Ft.-Lieut. Francis Chichester. Pp. 20+3 charts. (London : George Allen and Unwin, Ltd., 1943.) 7*s*. 6*d*. net.

THIS book supplies a lot of useful information for those engaged in air-navigation star-work, and follows the procedure adopted in the "Air Almanac", dividing the stars into three Lots : Lot 1 contains 22 main stars which are printed in capitals; the 13 stars in Lot 2 are in italics, and Lot 3 contains 15 stars considered third class for air navigation; but Benetnasch and Polaris are now included among the 24 main air navigation stars, Polaris, though only second magnitude, being considered much more valuable to the navigator than any other stars. Very full directions are supplied for the identification of the stars in various quarters of the heavens, and some space is also devoted to a description of the appearances of the navigational planets, Venus, Mars, Jupiter and Saturn, and to the method for recognizing them. On a Mercator's projection 390 stars are charted, and these include all the first-magnitude stars, nearly all the second-magnitude stars, 247 third-magnitude stars, and 8 fourth-magnitude stars (Polaris cannot be shown on a Mercator's projection and hence does not appear on the chart). A duplicate projection on which the stars are not named provides a useful test for the identification of stars—first-magnitude especially—and will show the student his weakness in star recognition.

Identification of the stars by means of the Mercator star chart and also by computed declination and sidereal hour angle is described, and an example of the application of the former method is given. At the end of the work there is a "Catalogue of First Magnitude Stars, given in Order of their S.H.A., with their Mean Positions for January 1943 in Terms of Dec., S.H.A., and R.A., with Annual Variations for the Middle of the Year".

This is a most useful book for air navigators. With the star charts, which fold up, it is enclosed in a glazed linen folder.

Radio-Technology

By B. F. Weller. Pp. viii+358. (London : Chapman and Hall, Ltd., 1943.) 21*s.* net.

THE author of this book is a practical radio-engineer, who has had some experience in teaching the subject ; and he has endeavoured to provide an intermediate practical text-book suitable for students preparing for some of the recognized examinations in radio-communication. The reader is assumed to have a fundamental knowledge of electricity and magnetism, including the principles of alternating currents, and a mathematical ability normally associated with practical electrical engineering.

The scope of the work is approximately that of the terminal equipment—transmitters and receivers—required for radio-communication purposes. After an introductory chapter on alternating currents and resonant circuits, the general principles of the production of radio-frequency oscillations are described in Chapter 2. The properties of thermionic valves, from diodes to pentodes, are next dealt with, together with the circuit arrangements used for applying valves as rectifiers, amplifiers and oscillators.

This leads to a treatment of the principles of radio transmitters, and the keying and modulation methods used for telegraphy and telephony. Two chapters are then devoted to the general principles of reception, and the supersonic heterodyne type of receiver now so widely used for radio-communication purposes. A chapter on the various types of modern aerial systems and their relevant characteristics concludes the book.

The treatment throughout is descriptive of the technological principles of the subject without reference to any specific equipment, and should thus prove valuable to the practical operating and installation engineer who desires to acquire a closer fundamental knowledge of the branch of engineering in which he is engaged.

The Manure Note Book

A Handy Guide for Manure Manufacturers and Merchants, Farmers, Agricultural Students and Horticulturalists. By John Stewart Remington. Pp. v+58. (London: Leonard Hill, Ltd., 1943.) 3*s.* 6*d.*

THE first chapter of this book is devoted to a brief account of the constitution of soils and the composition of plants. Then follow two short chapters on the origin and use of farmyard manure and fertilizers supplying nitrogen. Chapter 4 is headed "Phosphatic Manures", but after a description of the commoner phosphatic fertilizers, gives an account of the origin, characteristics and uses of potash manures and lime, the residual effects of manures and the manurial requirements of some of the common crops. A short chapter on manures for fruit trees is followed by a collection of manure recipes for a wide range of agricultural and horticultural crops and a number of conversion tables, and tables of equivalence relating to materials used in the manufacture of fertilizers. The last fifteen pages of the book are devoted to tables showing the percentage of any nutrient in a fertilizer mixture from the weight of the fertilizer salt supplying that nutrient which is included in each ton of the mixture.

The manure recipes and the manurial requirements of crops are dealt with from the pre-war point of view. No reference is made to the present restrictions on the use of fertilizers or to some of the more modern fertilizers. Some of the fertilizer recommendations are not in agreement with the results of recent experimental work, and the inclusion of sulphate of potash in a special turnip and mangold manure while kainite is used in a potato manure seems difficult to justify. The book is likely to be appreciated more by the manure manufacturer than the farmer. F. H.

The Natural Development of the Child

A Guide for Parents, Teachers, Students and Others. By Dr. Agatha H. Bowley. Second edition. Pp. xvi+184+30 plates. (Edinburgh : E. and S. Livingstone, 1943.) 8*s.* 6*d.* net.

THE appearance of a second edition of this work, little more than a year after it was originally issued, is itself sufficient tribute to the way it has been received. Dr. Bowley set out to help parents and teachers who need guidance about the emotional development of children. To do this she has not only read widely—each chapter ends with a list of references—but also has arranged various investigations at the school psychological departments with which she has been connected. Having collected the material, the author has not impaired the value of her work by the inclusion of technical descriptions ; the book is intended for the non-specialist and in no part does it become too difficult for them. It is crammed with useful information for parents and teachers and, albeit inadvertently, shouts the need for more and more parents and teachers who are really fitted to guide young children towards maturity. "The Natural Development of the Child" continually raises the question as to whether the ability to produce a child is in itself sufficient justification for the parent to constitute himself or herself the most suitable guardian of the child. One also wonders if the ability to teach reading or writing or any of the 'ologies' should continue to be recognized as the main qualification required to help the child in its adjustment to life. T. H. H.

Map Reading and Avigation

An Introduction. By Richard M. Field and Harlan T. Stetson. Pp. xiii+129. (London: Chapman and Hall, Ltd., 1943.) 15*s.* net.

THE aim of this book is to provide an introduction to the subject for air cadets. The first half treats of map-reading from the point of view of the aviator, and is illustrated entirely from American maps, and even these, on account of censorship, have had to be chosen with discretion. The treatment is summary and omits some of the more familiar considerations generally embraced in the study of maps for surface travel. Particular attention is paid to the relation between aerial photographs, block diagrams and topographical surveys, and many well-devised exercises and problems are included. If space was a consideration, it is difficult to understand why a brief résumé of the physiographic region of the United States and Canada and a section on the moon should be included.

The second half of the book, and probably the most useful, is an introduction to air navigation for which the author uses a word of doubtful legitimacy, 'avigation'. This section is clear and lucid, and requires a minimum of mathematical skill. The relative merits of Mercator and the Lambert conformal projections are discussed. The diagrams are well drawn. A list of reference books and charts includes only United States publications. On the whole, it is a useful book and is admirably illustrated.

MEASURING THE DISTANCE OF THE SUN FROM THE EARTH*

By Sir HAROLD SPENCER JONES, F.R.S.
Astronomer Royal

THE distance of the sun from the earth or, speaking more correctly—for the distance is, of course, variable—the semi-major axis of the earth's orbit, is the most important constant in astronomy. It determines the scale not merely of the solar system but also of the whole universe. It enters into almost any calculation of distances and masses, of sizes and densities, either of planets or of their satellites or of the stars. Any error in its determination is multiplied and repeated in many different ways. The measurement of the sun's distance with the highest attainable accuracy is therefore of great importance in astronomy, and it is not surprising that vast amounts of time and labour have been devoted to it by astronomers in the course of centuries.

Many different methods are available for determining the sun's distance. They can be grouped into three main classes: geometrical methods, gravitational methods and methods involving the velocity of light. I shall deal primarily with the geometrical methods, those which depend upon direct measurement. But first I shall refer briefly to the other methods, which are indirect.

Gravitational Methods

The gravitational methods depend upon the fact that there is a theoretical relationship between the distance of the earth from the sun and the ratio of the mass of the earth to that of the sun. This relationship, which involves the length of the seconds pendulum and the length of the sidereal year, is known with great exactness; it is one of the best established results of celestial mechanics and is the principle on which the lunar theory is constructed.

Now the perturbing effect of the earth on the motion of a nearby planet, such as Mars or Venus, depends upon the ratio of the masses of the earth and the sun. If, then, by analysing the motion of the planet the perturbing effect of the earth is determined, we can infer the distance of the earth from the sun. But, on closer examination, it is found that the mass of the earth can not satisfactorily be determined from its action on the other planets, because the observations are affected by errors of a systematic nature, which it is impossible to control satisfactorily. When the errors of observation are of a purely random or accidental nature, increased precision in the quantity to be determined—in this case, the mass of the earth or the distance of the sun—can be obtained by increasing sufficiently the number of observations. But when, on the other hand, all the observations are affected in a similar way by a certain source of error, there is a limit to the precision attainable, and no increase in the number of observations will give a precision within this limit. The causes that limit the precision with which the mass of the earth can be derived from observations of Venus or Mars do not apply in the case of the minor planet Eros, which has an orbit of high eccentricity and a star-like image. The orbit of Eros has been determined with high accuracy and it is possible that the most accurate determination of the sun's distance will eventually be inferred from the mass of the earth derived from the perturbations produced by the earth in the motion of Eros. Time is on the side of this method, and as observations of the position of Eros accumulate the precision of the determination will increase.

Another gravitational method by which the mass of the earth and the distance of the sun can be derived is worth mentioning, because of its intrinsic interest. The orbits of the planets are subject to slow secular changes caused by the perturbing actions on each planet of the other planets. These secular changes can be deduced from the accumulated observations of the planets and compared with their theoretical expressions, which involve the masses of the planets; in this way the masses of the planets can be inferred. For many years a large and unexplained discordance in the motion of the perihelion of Mercury remained one of the outstanding problems of gravitational astronomy. This was at length satisfactorily accounted for by Einstein's generalized theory of relativity. But there was also another serious discordance: the mass of the earth derived in this way corresponded to a distance of the sun which was considerably greater than the distance derived by every other method. I have rediscussed these secular changes, introducing all the corrections required by the theory of relativity, and the discordance still remains. It arises almost entirely from a disagreement between the observed and theoretical motions of the node of the orbit of Venus. Observations of the transits of Venus and meridian observations of Venus show about the same discordance. This anomaly in the motion of the node of Venus has remained unaccounted for after the most exhaustive discussion. As the American astronomer, Simon Newcomb, said, "What adds to the embarrassment and prevents us from wholly discarding the suspicion that some disturbing cause has acted on the motion of Venus, or that some theoretical error has crept into the work, is that, of all the determinations of the Sun's distance, this is the one which seems the most free from doubt arising from possible undiscovered sources of error". Again, "Unknown actions and possible defects of theory aside, it seems to me that the value of the Sun's distance derived from this discussion is less open to doubt from any known cause than any determination that can be made". Yet determinations of the sun's distance by every other method suggest that the distance obtained in this way is seriously in error.

A third gravitational method is based on the determination of an inequality in the motion of the moon known as the parallactic inequality. The disturbing action of the sun on the moon is greater at new moon than at full moon because the moon is nearer the sun when new than when full. In consequence the time of first quarter is slightly retarded and that of last quarter is slightly accelerated. The parallactic inequality involves the sun's distance, and this can therefore be inferred when the parallactic inequality is determined from the analysis of the moon's motion. The determination of this inequality from meridian observations of the moon is peculiarly liable to systematic error, because observations have to be made on one limb of the moon when the inequality is positive and on the other limb when it is negative; any error in the adopted semi-diameter of the moon therefore enters almost to its full amount into the derived value of the inequality. It is better to use observations of occultations of stars by the moon. Near first quarter the stars dis-

* Royal Institution discourse delivered on January 28.

appear, as the moon moves eastwards relative to the stars, at the dark limb of the moon; these disappearances can be accurately observed. The stars reappear at the bright limb and, because they are likely to be lost in the glare of the moon at the instant of reappearance, the time of reappearance is almost certain to be late. Near last quarter, the stars disappear at the bright limb and may be lost in the limb glare before the instant of true occultation, so that the observed time of disappearance is likely to be early. They reappear at the dark limb and the instant of reappearance should be accurately observed, provided the observer is looking at the right spot. The systematic errors which may thus be introduced can be controlled by discarding observations at the bright limbs, except those of stars sufficiently bright to be seen readily at the limb. With proper precautions, a good determination of the sun's distance can be made from observations of occultations.

Velocity of Light

Of the methods involving the velocity of light the first is of historical interest only. In 1675 Römer had proved that light does not travel instantaneously, but with finite velocity. He found that the eclipses of Jupiter's satellites occurred later than they should when the earth was on the far side of its orbit from Jupiter, and earlier when the earth was on the near side of its orbit. The extreme difference in time, amounting to about 16½ minutes, represents the time required by light to travel across the diameter of the earth's orbit. As the velocity of light is now known with high precision, the distance of the sun can be inferred from observations of the times of eclipses of Jupiter's satellites. But this method does not permit of high accuracy.

A better method is provided by the phenomenon of aberration, discovered by James Bradley in 1728. Bradley had been puzzled by certain anomalies in his measurements of the positions of stars. The stars seemed to be pushed slightly out of their places, always towards the direction of the earth's motion. Bradley puzzled for a long time about the cause of these displacements; but at length he correctly explained them as due to the finite velocity of light. The direction in which a star is seen depends upon the motion of the earth and the finite speed of travel of light, and as the earth travels round its orbit in the course of a year, a star appears to describe a small ellipse in the sky. The displacements in the positions of the stars depend upon the ratio of the speeds with which the earth and light travel. This ratio is called the constant of aberration, and there are many ways in which it can be determined by astronomical observations. The velocity of light being known, the constant of aberration determines the speed of the earth. But the speed of the earth is related to the size of its orbit, for its orbital path is described in one year and, the speed being known, the size of the orbit and, consequently, the distance of the sun can be inferred.

It might be thought, therefore, that from the many determinations of the aberration of the stars, the distance of the sun could be found with very high precision. But the method proves to be attended with serious difficulties. The measurement of aberration depends essentially on the comparison of the apparent positions of stars obtained at intervals of about six months, when the earth is at opposite ends of its orbit. Moreover, the observations at one season must be made soon after sunset and at the other season shortly before sunrise. Thus all sorts of troublesome errors of a systematic nature, involved in seasonal and diurnal changes, are liable to enter. The errors bound up with seasonal climatic variations are among the most troublesome in astronomy, and it is practically impossible to eliminate them. For this reason it is preferable not to use the constant of aberration as a means of inferring the sun's distance, but to use the sun's distance, determined by other methods, to infer the constant of aberration.

Of the methods for finding the sun's distance that involve the velocity of light, the most promising is based on the measurement of the exact positions of the lines in the spectra of selected bright stars near the ecliptic. The motion of the earth towards or from a star alters the wave-lengths of the spectral lines, causing them to shift slightly to and fro. The shifts in the wave-lengths of the lines depend upon the velocity of the earth towards or away from the star. This again leads to a determination of the sun's distance. Some observations at the Cape by this method gave promising results, but long-continued observations on a number of bright stars, using a very large telescope and a spectrograph of high dispersion, are required in order to obtain an accurate result. The many demands on the observing time of powerful telescopes have prevented the method being given an adequate trial. A difficulty of the method is that any changes in the motion of the star itself—such as orbital motion or pulsations in its atmosphere—also give rise to displacements in the positions of its spectral lines and, unless these can be allowed for or are of a random nature, the accuracy of the result will be impaired. It is also necessary to take careful precautions that no displacements of instrumental origin, such as might be caused by instrumental flexure, can occur.

Direct Observation Methods

We come now to the determination of the sun's distance by direct observation. This type of method depends upon the measurements of angles. The process is essentially the same as that used by a surveyor in the measurement of the earth's surface by triangulation. He starts with an accurately measured base-line and determines the distance of a far point by measuring, from each end of the base-line in turn, the angle between the base-line and the direction to the far point. This enables him to calculate the distance of the point from each end of his base-line. In the case of the sun, the angle to be measured is what is called the horizontal parallax of the sun—or, more briefly, the solar parallax; it is the amount by which the sun at rising or setting is apparently moved—to an observer on the rotating earth—from its true place in the heavens. This angle of parallax (about 8·8″) is the angle subtended by the radius of the earth as seen from the sun. It is about equal to the diameter of a halfpenny as seen 2,000 ft. away. It will be understood that to determine this small angle with an accuracy of about one part in ten thousand is far from an easy matter.

The sun is a difficult object for accurate measurement under the best conditions; its large size and the effect of its heat on the instruments used limit the accuracy of the measurement. If the distance of the sun could not be determined otherwise than by direct observation of the sun, it would be a vain hope to expect an accurate answer. But, fortunately, this is not necessary. The laws governing the motions

of the planets which were enunciated by Kepler in the year 1618 enable the relative distances of the planets in the solar system to be inferred with very great accuracy from the periodic times in which their orbits are described. The solar system can therefore be accurately drawn to plan; the scale of the plan is fixed when any one distance in it has been measured. The smaller the distance, the more favourable are the circumstances for accurate measurement, because the angle of parallax—from which the distance is inferred—is larger in relation to the errors of observation. From time to time, one or other of the planets in their unending journey round the sun comes sufficiently near the earth to enable the sun's distance to be measured with reasonable accuracy. The two planets which appeared to offer the best scope for measuring the sun's distance by direct observation were Mars and Venus. Venus comes closer to the earth than Mars does; its nearest distance is about 26 million miles, whereas Mars, when nearest, is 34½ million miles away. But Venus, when at its nearest, is between us and the sun. It then becomes lost to sight in the rays of the sun and it is only on the somewhat rare occasions when its path lies directly in front of the sun and it can be seen to transit across the sun's disk that measurements become possible. Four transits of Venus occur every 243 years, at successive intervals of 8, 105½, 8 and 121½ years. Five transits only have ever been observed, namely, the transits of December 4, 1639; June 6, 1761; June 3, 1769; December 9, 1874; and December 6, 1882. The next two will occur on June 8, 2004, and June 6, 2012. It was Halley who first suggested in 1679 that the transits of Venus would provide favourable opportunities for determining the sun's distance.

But the first scientific estimate of the distance of the sun was made from observations of Mars. The orbit of Mars is more elliptical than the orbit of the earth, so that the distance of Mars from the earth when in opposition, that is, with the earth directly between Mars and the sun, can range from 34½ million to 63 million miles. The favourable oppositions, when the distance is least, occur at intervals of fifteen or seventeen years, in August. Mars, when in opposition, crosses the meridian at midnight and is suitably placed for observation. A favourable opposition occurred in 1672. Observations to determine the sun's distance were planned by Giovanni Domenico Cassini, the first director of the Paris Observatory, then just completed. He sent an expedition to Cayenne to make observations of Mars, while corresponding observations were made at the Paris Observatory. Paris and Cayenne thus formed the ends of a base-line, and from the difference in the direction of Mars as seen from the two places the distance was to be inferred. The result of the observations was to place the sun at a distance of between 82 and 91 million miles, with a probable value of 86 million miles—a value that was accepted for about a century.

The determination of the distance of the sun by observations of Mars in this manner is liable to a very serious systematic error. At each station the position of Mars in the sky is determined with reference to adjacent stars. The effect of parallax is to displace Mars away from the zenith. Atmospheric refraction, on the other hand, displaces it towards the zenith; but as it displaces the stars also towards the zenith, its effects would be eliminated if Mars and the stars were refracted by the same amount. Refraction, however, is greater for blue than for red light, because of the dispersive power of the atmosphere. Because Mars is redder than the average star, it is displaced by refraction towards the zenith by an amount that is smaller than the average amount by which the adjacent stars are displaced. Hence, as compared with the stars, Mars will be effectively displaced away from the zenith. This differential displacement, caused by atmospheric dispersion, will be interpreted as the effect of parallax. The measured parallactic displacement will therefore be too great, and too large a value of the solar parallax, corresponding to too small a distance of the sun, will be inferred. The distance found in 1672 was, in fact, appreciably too small.

In 1877, Gill made an expedition to the Island of Ascension to make observations of Mars at a favourable opposition in order to determine the solar parallax by a method which Airy, the Astronomer Royal, had recommended. Its principle consists in substituting successive morning and evening observations from the same spot for simultaneous observations from two different spots, the rotation of the earth supplying the necessary difference in the points of view. Gill made his observations with an instrument termed a heliometer, which has an objective divided into two halves along a diameter. The two halves can be displaced relatively to one another, enabling the images of two objects, for example, Mars and a star, formed by the two halves separately, to be brought into coincidence. An accurate measure of the angular distance between the two objects can be inferred from the separation of the two halves of the objective required to give coincidence. Gill obtained a low value for the solar parallax, 8·78″, instead of the high value that would be expected. Newcomb, in collating various determinations of the solar parallax, rejected all those based on observations of Mars, with the exception of Gill's. He remarked: "It may be objected that it should be rejected for the same reason, since the colour of the planet would affect heliometer observations and meridian observations equally. I have, however, considered it free from the objections in question for two reasons. In the first place, the result is not too large, but is, on the contrary, the smallest of all the accurate measures. The principle that when a result is open to a strong suspicion of being affected by a cause which would cause it to deviate in one direction, it is logical to conclude *a posteriori* that the cause has not acted if the deviation is found to be in the other direction, may not be a perfectly sound one, but I have nevertheless acted upon it".

The explanation of Gill's low value of the parallax was not found until 1924 and is of some interest, as illustrating how systematic errors can enter into such observations and lead to erroneous results. In 1924 there was another favourable opposition of Mars, and I arranged a programme of observations at the Cape, which was shared by three observers, Dr. Halm, Mr. Wilkin and myself. These observations gave again a low value of the solar parallax, 8·76″, even lower than Gill's value. The same value was obtained from the observations of distances, position angles or right ascensions, so that the observations were internally consistent. When, however, the observations were grouped according to the observers, surprisingly large differences were obtained:

Halm	.. ..	8·70″ ± 0·02″
Jones	.. ..	8·77 ± 0·02
Wilkin	.. ..	8·81 ± 0·02

The differences were much greater than the probable errors. Such a result had not been expected, because adequate precautions had been taken to guard against errors of 'personality'.

Now there was one, and only one, point on which the observers had differed. With the heliometer a series of graded wire-mesh screens are used, which can be placed at will over either half of the objective, so as to reduce the brightness of the object viewed. It was left to the judgment of each observer which screen should be used under any particular conditions of observation. Halm used the densest screen, even in cases where measurement would be possible with a more open one; Wilkin showed great reluctance in using the dense screen, while I adopted an intermediate attitude, using the less dense screens for preference, but falling back on the densest screen whenever observations became at all difficult with the other screens. The presumption that the use of the densest screen gave the lowest value of the solar parallax could be checked in two ways: (*a*) under conditions of bad seeing, the image of a star becomes weak and diffused instead of appearing as a bright point of light, and it is then lost against the bright disk of Mars unless the densest screen is used to reduce sufficiently the brightness of Mars; thus we may expect a smaller value of the solar parallax to result from the nights of bad seeing than from the nights of good seeing; (*b*) for similar reasons, the densest screen had to be used more frequently when observing faint stars than when observing bright stars, so that again we may expect to find a smaller value of the parallax from observations of faint stars than from observations of bright stars. These expectations were confirmed and in each case the zenithal displacements required to account for the observed discrepancies were calculated. The results were as follows:

	Zenithal displacement		Difference in
	From R.A.	From Dec.	solar parallax
Jones—mean . ..	+0·02″	+0·04″	+0·01″
Halm— ,, ...	−0·13	−0·14	−0·06
Wilkin— ,, ...	+0·10	+0·10	+0·05
Bad—good seeing .	−0·15	−0·16	−0·08
Faint—bright stars .	−0·13	−0·12	−0·05

The agreement in each case in the zenithal displacements deduced from right ascensions and declinations separately demonstrates conclusively that the phenomenon has its maximum effect in the direction towards or from the zenith. Now it is a well-known fact that the sensibility of the human eye for colour depends on the intensity of the light source. The more the intensity of the light of Mars is diminished, the more sensitive does the observer become to the blue portion and the less sensitive to the red portion of its spectrum. With the densest screen the ruddy appearance of the planet was, in fact, completely lost. The conclusion is that the screens used for reducing the light of the planet show a tendency to enhance the susceptibility of the observer for the more refrangible portion of the planet's light and consequently displace the apparent disk towards the zenith as the result of atmospheric dispersion. Thus when observing with the heliometer, there is a tendency for too small a value of the solar parallax to be given by observations of Mars, contrary to what might have been expected.

Transits of Venus

Of all the methods of determining the solar parallax, the observation of the transits of Venus is the one that has raised the highest hopes, that has involved the largest expenditure of energy and resources and has proved the greatest failure. As viewed from remote parts of the earth, the track of Venus across the disk of the sun will be different, and the times of beginning and ending the transits will be different. The differences of path or of time can be translated into differences of space, and the distance of Venus and hence of the sun inferred. As Halley said, when emphasizing the advantages of the method, the times of beginning or ending the transit could be determined with accuracy "without any other instruments than telescopes and good common clocks, and without any other qualifications in the observer than fidelity and diligence, with a little skill in astronomy". So the astronomers of the eighteenth century were full of hope and of zeal as the two transits of 1761 and 1769 drew near. The principal Governments of Europe fitted out expeditions to various parts of the world, observers being scattered to many stations over the face of the earth. It is worthy of note that it was the transit of 1769 that gave Captain Cook his chance to establish his fame as a navigator. He took a party of observers in the *Endeavour* to Tahiti in the South Seas and, after the transit had been observed, completed his three-year voyage round the world. Mention may also be made of the ill fortune that befell the French astronomer Le Gentil. He had intended to observe the transit of 1761 at Pondicherry, but the war between the French and the English caused him to arrive too late. He decided to remain there for eight years to make certain of observing the transit of 1769, but clouds at the critical time prevented him from seeing anything. On his eventual return to France, he found that during his long absence he had been adjudged legally dead and all his property had been divided amongst his next-of-kin!

The results of these observations were disappointing in the extreme. Unexpected difficulties were encountered in determining the exact instants of contact between the dark disk of Venus and the bright disk of the sun. Instead of meeting and parting with a clean definiteness that had been looked for, they appeared to cling together, a black spot seeming to form between the edge of Venus and the edge of the sun, somewhat as a drop of ink clings to a pen which is slowly withdrawn from an inkpot. The results obtained by the various expeditions were very different and discordant, and the uncertainty in the sun's distance remained at several millions of miles.

As the transits of 1874 and 1882 approached, it was confidently expected that they would give a final answer to the question of the sun's distance. It was believed that the difficulties experienced in 1761 and 1769 would yield to the skill of forewarned preparations. More than a century had passed and not in vain. There had been during that time many improvements in instruments, in methods of observation and in technique. Photography was being developed as an aid to the astronomer and much was hoped from it; though there might be difficulty in co-ordinating and interpreting visual observations, the camera could not lie and would be free from bias. The camera and the heliometers would both enable the position of the dark body of Venus seen against the bright background of the sun to be accurately determined, free from any peculiar phenomena, at the contacts. So the most intensive scheme of international co-operation that astronomy had yet seen was organized well in advance. Official commissions were appointed to consider the best methods of observations. Models

were constructed to train the observers and to determine their personal equations. Special instruments were made to ensure uniformity in equipment and method. Great Britain, France, Germany, Italy, Russia, Holland and the United States co-operated and some four score stations were occupied, at a cost of nearly a quarter of a million pounds. Siberia, the Sandwich Islands, Kerguelen and the almost inaccessible St. Paul's and Campbell Islands were among the places to which expeditions were sent. The weather proved generally favourable; the well-organized arrangements proved equal to the test; the contacts were well observed and many photographs were obtained.

Yet the results proved a great disappointment. The 'black drop' again gave trouble, but not more than was expected. More troublesome was the illumination due to the atmosphere of Venus, which caused the planet to be illuminated with a ring of light; its power to mar observations by the distorting effect of refraction had not been foreseen. So uncertain were the instants of precise contact that observers, with identical equipment, and standing a few feet from one another, recorded times that differed by as much as a minute. Photography, on which such high hopes had been based, proved an almost total failure. The great campaign left the distance of the sun uncertain by about $1\frac{1}{2}$ million miles.

Chastened but undaunted, preparations for the second transit were pushed ahead, in the hope that benefits could be obtained from the experience gained in 1874. Some countries withdrew on the ground that other methods of finding the sun's distance were more accurate and less costly. The arrangement of the observations was discussed by an international conference in Paris in 1881. Again there were many expeditions, the British parties being scattered from Queensland to Bermuda: visual and photographic observations were once more tried. The results were once more disappointing; the distance of the sun came out at $92\frac{1}{2}$ million miles, but the diversity of results given by the different expeditions and by different methods of discussion showed that no great confidence could be placed in this value.

The Asteroids

But meanwhile other objects more suitable for observation than Mars or Venus had come within the range of celestial trigonometry. In the wide gap between the orbits of Mars and Jupiter there exists a swarm of tiny planets or asteroids circling round the sun. The first to be discovered was found on the night of January 1, 1801, by the Sicilian astronomer, Piazzi, and was named by him Ceres, after the tutelary deity of the island. About a couple of thousand of these small bodies are now known. Most of the asteroids are of little intrinsic interest, and the somewhat monotonous work of keeping track of them is carried on because from time to time one of them proves to be of special interest. In 1872, it was suggested by Galle that some of the asteroids might repay astronomers for much of their disinterested toil in keeping track of them, by aiding their efforts to determine the scale of the solar system. Some of them are sufficiently bright and come near enough to be of use for this purpose and, being small enough to appear like a star in the telescope, they have a distinct advantage over Mars or Venus, with their large disks. In 1888 and 1889, from observations of the three asteroids, Victoria, Iris and Sappho, Gill obtained a solar distance of 92,874,000 miles—undoubtedly the most accurate determination that had been made up to that time.

The 433rd asteroid to be discovered, found on August 14, 1898, and named Eros, proved to be of singular importance for measuring the sun's distance. It is a small body, only some 15 miles in diameter, with an orbit so elliptical that from time to time it comes within about 15 million miles of the earth. One such near approach had occurred in 1894, shortly before its discovery. Since then its nearest approaches have been in 1901, when its least distance was somewhat less than 30 million miles, and in 1931, when its least distance was only 16,200,000 miles, affording the most favourable opportunity that has ever occurred for determining the sun's distance. Extensive observations of Eros were obtained in 1901. But the observations were far more numerous in 1931; the circumstances were far more favourable at the latter date, and the great advances made during the present century in the applications of photography to precise astronomical measurements enabled greater accuracy to be obtained in the more recent observations. The results from the 1931 observations will therefore alone be referred to.

Observations of Eros in 1931

The observations were almost entirely photographic; the method used was to photograph Eros and the surrounding stars on the same plate and then, by careful measurement, to determine the exact position of Eros among the stars. A base-line can be obtained by using two different observatories and combining the observations to give the relative displacement of Eros as seen from the two ends of the base-line; or the base-line can be provided by the rotation of the earth, the observations at the same observatory in the evening and the following morning being combined. During the interval between the observations, both the earth and Eros have moved somewhat along their orbits round the sun. The displacement during this interval in the position of Eros as seen from the earth must be allowed for. This is not a matter of great difficulty when the paths of Eros and the earth round the sun are accurately known. Now it is usually stated that the path of a planet round the sun is an ellipse. This would be so if there were no other planets. But gravitation is a universal force. It is the gravitational pull of the sun that compels the earth to travel round the sun; but all the while each of the other planets of the solar system is also exerting a gravitational pull on the earth, which depends on the mutual distance between the earth and the planet, and the pull is continuously changing as the earth and the planet move. The effects of the gradually varying pulls of the other planets on the earth and on Eros must be determined and taken into account when calculating the paths of the earth and of Eros. This is a long and intricate task, which was undertaken by Dr. Witt, the discoverer of Eros.

As the positions of Eros had to be derived by reference to adjacent stars, it was necessary to determine specially the positions of a sufficient number of stars for this purpose. A selection of 900 stars, bright enough to observe with meridian instruments and lying in a narrow belt extending 1° on either side of the path of Eros, was made. These stars were sufficient in number to average ten or twelve on a plate, centred at any point on the path of Eros and covering the field of $2° \times 2°$, obtainable with instru-

ments having a focal length up to about 12 ft. Their positions were determined at thirteen different observatories and combined into a definitive catalogue on a homogeneous system at the Rechen Institut, Berlin. But photographs with modern long-focus instruments cover a much smaller field, and the primary reference stars were too few in number to enable the positions of Eros to be derived from these photographs. A selection of some 6,000 fainter secondary reference stars was therefore made, the positions of which were obtained by photographic methods, using the primary stars as reference points. Special series of photographs were obtained for this purpose at the Greenwich, Bergedorf, Leipzig and Cape Observatories and combined into a definitive catalogue at Greenwich.

The path of Eros during the time when its parallax was large enough for observations to be worth while was in the form of a large arc across the sky, from north to south. It was at first only observable at northern observatories, but as it moved rapidly southwards it came within range of southern observatories, and eventually passed out of range of most of the northern observatories. Observations were obtained at some three dozen observatories, scattered over the world in all five continents. But the visual observations proved to be considerably inferior in accuracy to the photographic, and the derivation of the solar parallax was eventually based on photographic observations with thirty telescopes at twenty-four observatories in England, the U.S.S.R., Germany, Belgium, Czechoslovakia, Italy, Spain, Algiers, the United States, China, Japan, South Africa, Australia and the Argentine. 2,847 plates were measured and used.

The solar parallax can be derived from the observations in several ways. First, using the diurnal method, each instrument with which observations on several nights with a sufficient range in parallactic displacement were obtained will give a determination. Sixteen separate determinations were thus obtained, as shown in Table 1. The relative weights are based on the probable error of each determination. The weighted mean value is 8·7900″ ± 0·0013″.

TABLE 1. SOLAR PARALLAX: SEPARATE DETERMINATIONS FROM RIGHT ASCENSIONS.

Instrument	Parallax and p.e.	Relative weight
Cape 13-in.	8·7886″ ± 0·00165″	36·7
Cape 24-in.	8·7902 ± 0·00175	32·6
Cordoba	8·7928 ± 0·0024	16·4
Allegheny	8·8020 ± 0·0035	8·1
Van Vleck	8·7676 ± 0·0048	4·3
Dearborn	8·8070 ± 0·0061	2·7
Zô-Sè	8·7868 ± 0·0049	4·2
Union Obs.	8·7918 ± 0·0074	1·8
Lick	8 7887 ± 0·0080	1·6
Melbourne	8·7949 ± 0·0082	1·5
Greenwich 13-in.	8·7648 ± 0·0078	1·6
Greenwich 26-in.	8·7820 ± 0·0115	0·8
McCormick	8·7861 ± 0·0091	1·2
Washington	8·8160 ± 0·0101	1·0
Tokyo	8·7459 ± 0·0183	0·3
Catania	8·7865 ± 0·0336	0·1

The internal consistency of the results can be examined by subdividing the material in different ways. First, the three series with preponderating weight, on which the combined weighted mean value will largely depend, can be separated from the other thirteen series and the separate mean values compared. Secondly, those determinations based on primary star places can be compared with those based on secondary star places, to see whether there is any systematic effect connected with the brightness of the comparison stars. Thirdly, the results obtained with instruments designed for photographic observations can be compared with those obtained with visual instruments, used photographically by employing yellow sensitive plates and yellow filters. In each case there is a satisfactory accordance.

The results derived in this way are independent of systematic corrections required by individual instruments, but a considerable wastage of material is involved. Not only are unbalanced observations excluded (that is, where evening or morning observations, but not both, have been obtained), but also observations with other instruments the series of which were not sufficiently complete, have not been used at all. New solutions were therefore made, night by night, using all available material. 129 separate determinations of the solar parallax were thus obtained, with the weighted mean value 8·7875″ ± 0·0009″. The internal consistency was checked by dividing it into four groups of approximately equal weights; these gave values in close accordance.

An entirely independent determination of the parallax can be made by comparing observations at a northern and a southern observatory, the base-line being provided by the line joining the two observatories. This method uses observations in declination, instead of in right ascension. The results of a series of separate determinations are given in Table 2. The results are not entirely independent, because some of the material is used several times over, but they show the general consistency. Individual determinations were therefore made for each night on which sufficient observations at one or more northern and one or more southern observatories were obtained. Seventy-one separate determinations were thus made, giving a mean result of 8·7907″ ± 0·0011″. Dividing the material into three groups, concordant results were again obtained.

TABLE 2. SOLAR PARALLAX: SEPARATE DETERMINATIONS: N–S COMPARISONS

Instruments	Parallax and p.e.	No. of nights
Radcliffe: Cape 24-in.	8·7934″ ± 0·0026″	9
Greenwich 26-in.; Cape 24-in.	8·7935 ± 0·0040	9
Rad. + Gwh. 26-in.; Cape 24-in. + Yale	8·7908 ± 0·0026	13
Gwh. 13-in.; Cape 13-in.	8·8023 ± 0·0067	8
Dearborn; Cape 24-in.	8·7906 + 0·0033	28
V. Vleck; Cape 24-in. + Yale	8·7874 ± 0·0039	17
Algiers; Cape 13-in.	8·7886 ± 0·0028	49
Algiers; Cordoba	8·7865 ± 0·0033	30
Allegheny; Cape 24-in. + Yale	8·7840 ± 0·0037	22
Washington; Cape 24-in. + Yale	8·7870 ± 0·0058	14
McCormick; Cape 24-in. + Yale	8 7865 ± 0·0038	15
Lick; Cape 13-in.	8·7862 ± 0·0036	12
Lick, Cape 24-in.	8·7867 ± 0·0043	12
Lick; Cordoba	8·7909 ± 0·0086	9

Thus, summing up, the final results for the solar parallax from the Eros observations are:

R. A. Observations.

(*a*) Mean value from sixteen separate determinations, 8·7900″ ± 0·0013″.

(*b*) Value from all observations combined, 8·7875″ ± 0·0009″.

Dec. Observations.

(*c*) Value from all observations combined, 8·7907″ ± 0·0011″.

The three determinations are adequately represented by a value of the solar parallax of

8·790″ ± 0·001″;

corresponding to the sun's distance:

93,005,000 ± 9,000 miles.

The assigned probable error is based on the internal accordance of the observations. It is so small that the sun's distance is derived with an exactness adequate for all purposes unless there is some systematic error affecting all the observations. A possible source of such error is differential atmospheric dispersion, if the colour of Eros differs from

the colour of the average star. We have already seen that such errors can be considerable in the case of Mars. A very careful and detailed investigation into this possibility has been made. We have seen that if Eros is redder than the average of the comparison stars, we may expect to obtain too large a value of the solar parallax. Now a number of determinations of the colour of Eros were made, and it was found that it was slightly, but only very slightly, redder than the average of the comparison stars. Thus, on this showing, we might expect our concluded value of the solar parallax to be a little too large.

But the matter is not quite so simple as that. All the observations were made with refracting telescopes, in which the light is collected by lenses; none of them was made with a reflector. The aberrations of lens systems play a not unimportant part in modifying our conclusions, which are strictly applicable only to a perfectly achromatic instrument, in conjunction with a photographic emulsion equally sensitive to all colours. Thus, for example, to consider but one way in which the conclusions are modified: if a refractor of the normal astrographic type is focused to give the sharpest images at its centre then, at the edge of the plate, the rays that are brought to a sharp focus are not those which are photographically most effective, but rays of a somewhat greater wave-length. If, in measures of colour, there are two stars of the same colour, one at the centre of the plate, the other at the edge, the latter will appear the redder. Now, because Eros is always photographed at the centre of the plate, this effect will counteract in whole or in part the small difference in colour between Eros and the comparison stars. There are many other factors concerned, but the outcome of the discussion is that, with so many different instruments employed, what at first sight appeared to be a troublesome systematic error tends to assume a random nature. In so far as any residual systematic effect remains, it should be revealed by a correlation between the determined values of the solar parallax night by night and the distance of Eros; for the atmospheric dispersion effects are independent of the distance of Eros, whereas the parallactic displacements are greater the nearer Eros is to the earth. An investigation of the correlation between the solar parallax and the distance of Eros was made for both the right ascension and the declination observations. The deduced effects, which were comparable with their probable errors in each case, were of opposite sign in the two co-ordinates. The conclusion is that the general effects arising from colour differences between Eros and the comparison stars are negligibly small. This is a fortunate circumstance, and one that could not have been foreseen. The conclusion is corroborated by the agreement, within the limits of their probable errors, between the mean values of the solar parallax derived from photographic and visual instruments. Colour effects with the visual instruments are only two-fifths as great as with the photographic instruments; the concordance of the results from the two types shows that the effects are negligible.

One hundred years ago the distance of the sun was uncertain to one part in twenty; gradually, the uncertainty was narrowed to one part in a hundred, and then to one part in a thousand; now it has been reduced to one part in ten thousand. In 1858, Sir John Herschel, referring to a new determination of the sun's distance, which had brought the sun nearer by 4 million miles, wrote: "The superficial reader (one of a class too numerous) may think it strange and discreditable to science to have erred by nearly 4 million miles in estimating the Sun's distance. But such may be reminded that the error in the Sun's parallax, on which the correction turns, corresponds to the apparent breadth of a human hair at 125 feet, or of a sovereign at 8 miles off". The uncertainty in our latest determination corresponds to the apparent breadth of a human hair at 10 miles, or of a halfpenny at 3,250 miles! Looked at in another way, a similar accuracy in measurement of the distance of the moon would set the moon only 100 yards nearer to or further from us than it really is.

The goal for which astronomers have so long been striving has at length been reached. The final word has been said on this historic problem for many years to come, and the fundamental distance in astronomy has been measured with all the accuracy that is needed.

THE RAPID TREATMENT OF SYPHILIS

By Major JAMES MARSHALL, R.A.M.C.

RESEARCH into the problem of producing a safe and rapid method for the cure of syphilis has been given an added impetus during the war period, not only by an increase in the incidence of the disease, but also by the necessity for rapid rehabilitation of men who must be fit to move quickly and keep fit in conditions where continuous treatment may be impossible. The following account traces the evolution of the arsenical treatment of syphilis with special reference to intensive or massive arsenotherapy.

When Ehrlich, in September 1909, presented to Prof. Alt, for clinical trial, his preparation 'Ehrlich-Hata 606' he believed that he had discovered an immediately effective single-dose cure for syphilis. A year later Ehrlich, a little shaken, claimed that "606" in the original dosage was curative in 90 per cent of cases of syphilis. An accumulation of evidence in the form of relapsed cases soon showed, however, that the early high hopes could no longer be entertained. It is probable that a certain small percentage of cases of early syphilis are cured by one injection of "606"; but the difficulty of assessing cure makes the relative over-treatment of every case necessary in order to cover every eventuality.

In 1916 Pollitzer evolved a rapid treatment for early syphilis by three or four daily injections of arsphenamine, but here again early relapses proved the inadequacy of the scheme, and long-term investigation has shown that the end results of such treatment are very poor. Other like methods for the abortive treatment of early cases were found in time to be equally uncertain.

It finally became evident that the best prospect of cure was to be found in a treatment where a drug of the arsphenamine series was administered at the same time as a heavy metal preparation. Bismuth was found to be superior to mercury, and for the last twenty years has been the heavy metal of choice.

This combined scheme has proved highly successful and has stood the test of time, the most important test in the estimation of cure in syphilis. The great drawback is that, to be certain of effecting a cure, the patient must remain constantly under treatment for at least a year and sometimes longer. In principle

the present-day British scheme in common use for cases of early syphilis aims at administering about forty injections of a drug of the arsphenamine series and the same number of injections of a bismuth preparation over a period of about one year (standard scheme). The number of injections and time of treatment is increased in some cases, but is rarely reduced. The spacing and arrangement of treatment varies, naturally, in different hands, and a variety of arsenicals is in use. Neoarsphenamine is still generally used in Britain, but arsenoxide is beginning to become more popular.

Arsenoxide, known to, but discarded by, Erhlich, is not an arsphenamine, and does not need to be broken down in the body to become spirochæticidal. It is rapidly excreted, and, in the opinion of many venereologists, must be injected at least twice weekly to achieve results comparable with those obtained with single weekly injections of an arsphenamine. If arsenoxide is used on the standard treatment scheme, the number of visits by a patient to doctor or clinic is doubled, and the rate of default from treatment rises accordingly. Arsenoxide has many advantages in other directions and these will be discussed later. It is believed by some American authorities to be, in proper dosage, the equal of '606', which has not yet been surpassed as a spirochæticidal agent. Some arsenoxide preparations for injection are known as 'Mapharside' or 'Mapharsen', 'Neohalarsine', and 'Chlorarsen'. Of these 'Mapharside' is the preparation which has so far been most used in intensive treatments.

Although the progress in cases of early syphilis treated by the standard scheme is very good (approaching 100 per cent cures) if treatment is faithfully followed, well under 50 per cent of patients, by reason of default, receive enough treatment to ensure a cure-rate of more than 80 per cent.

It is obvious, therefore, that any method which will give a high rate of cure in a short time will be of the greatest value to the patient and to the State.

No real approach to the rapid treatment of syphilis was made until it was shown by Hirshfeld, Hyman and Wanger that 'speed shock' following injection could be avoided by slow intravenous drip. By slow injection at a rate of 2 or 3 c.c. per minute, toxic substances could safely be introduced into animals in doses much greater than by a rapid method.

The first application of this discovery was made in 1934 at the Mount Sinai Hospital in New York City, when a number of patients with early syphilis were given 4 gm. or later 5 gm. of neoarsphenamine by a continuous intravenous drip over a period of five days. Results were very good.

Later a similar scheme was instituted in which 'Mapharside' was substituted for neoarsphenamine. The optimum dose of 'Mapharside' was discovered, by trial and error, to be 1,200 mgm. given at the rate of 240 mgm. a day, in 2,400 c.c. of 5 per cent dextrose solution. The results with 'Mapharside' were also very good, and severe toxic reactions, a grave drawback with neoarsphenamine, were much reduced. Neoarsphenamine is not now used in intensive treatment. A modification of this five-day scheme is the administration of 'Mapharside' in divided doses by syringe at intervals throughout the days.

About 85 per cent of cases treated with neoarsphenamine and 82 per cent of those treated with 'Mapharside' were clinically and serologically well after periods of from six months to six years.

Since these original experiments a number of other intensive methods of treatment have been tried in early syphilis, ranging in duration from one day to thirty days of arsenical treatment. The arsenical used has been arsenoxide, usually 'Mapharside', and in some schemes bismuth has also been used. One of the most promising schemes involves one daily injection of arsenoxide for twenty days, to give a total dosage of 1,200–1,800 mgm. of 'Mapharside'.

The most important complication of intensive arsenotherapy is hæmorrhagic encephalitis, and the higher the dosage of arsenic the more likely appears to be the risk. Some investigators have attempted to achieve good results on small doses (less than 1,200 mgm.) of arsenoxide by combining fever therapy with arsenotherapy. In one such investigation, fever was induced by intravenous injection of typhoid vaccines four times in a treatment period of eight days. The most widely publicized combined fever and arsenic treatment is the one-day scheme in which 'Mapharside' is administered in the course of a ten-hour session of high fever (hyperthermy) at 106° F. It is still much too early to judge the results of this form of treatment. A premature account of this method by Paul de Kruif in the *Readers Digest* of September 1942 caused a great deal of confusion and unfounded dissatisfaction in the lay mind. The enormous circulation of the *Readers Digest* gave medical men in America, and also in Britain to a smaller extent, a good deal of extra work to explain just why every case of syphilis could not be cured in one day.

All intensive treatment for early syphilis must still be considered as being experimental, because enough time has not yet elapsed to exclude all possibility of late relapse in the patients so far treated. Only in the earliest series is it possible to hazard a reasonably accurate estimate of the cure-rate.

Hæmorrhagic encephalitis gives a fatality-rate of 1 in 111 in the five-day treatment with neoarsphenamine and 1 in 300 in the five-day treatment with 'Mapharside'. The fatality-rate with 'Mapharside' is at least four times as high as the fatality-rate from all causes in a standard scheme of treatment. In the case of the other schemes of intensive treatment the true fatality-rate cannot yet be assessed, but it is reputed to be lower than in the five-day scheme. The calculated mortality in the case of the twenty-day scheme is about 1 in 400.

Peripheral neuritis was a common and often severe complication in the neoarsphenamine series, and is encountered in cases treated with 'Mapharside' but in very much smaller numbers and seldom in severe form. Most of the toxic effects of the arsenicals which are seen in the course of a standard treatment can also be encountered in intensive treatment. Secondary fever and toxico-dermal reaction is a fairly common complication of the twenty-day scheme, and occurs about the ninth day.

Research by Padget has shown that 60 per cent of patients who had received so little as 4–6 injections of arsphenamine were 'cured', that is, they remained well and were serologically negative after a significant lapse of time. A 'cure'-rate of 85 per cent was attained only by those patients who had more than twenty-one arsphenamine injections combined with a heavy metal. The prognosis in the case of patients who received irregular or haphazard treatment was worse than in the untreated. The number of patients in civilian clinic practice in Britain who remain under treatment long enough to fall into this last group is regrettably small. Either patient or doctor may be

at fault, and the mechanism for the reclaiming of defaulters is not yet full enough in most areas.

It appears that intensive arsenotherapy offers in a short time as good, or even better, immediate results than the standard treatment scheme, but with a vastly increased risk of toxic effects and a risk of death four times as great. Between 95 and 98 per cent of patients complete treatment by intensive methods, and default is impossible in cases sent to hospital.

All the intensive treatment schemes so far detailed require the hospitalization of the patient. The risk of early muco-cutaneous relapse is about equal in the intensive and standard treatment schemes. Only early cases of syphilis can at present be treated by intensive methods, and the patients must be followed up for at least a year after treatment.

In the light of these limitations the application of intensive treatment must be restricted. An obvious use is in the case of key personnel in the Services, particularly the Navy and Merchant Marine. The benefits of returning a man to duty with no need for further treatment are obvious when it is remembered that many ships do not carry a doctor, and that haphazard treatment on standard lines may be worse than no treatment at all.

A potential use for intensive arsenotherapy might be in the case of persons who, notified under Regulation 33B, refuse to co-operate by placing themselves voluntarily under treatment when they are discovered to be infected with syphilis. This is naturally a hypothetical case and is open to criticism from both a legal and a medical point of view. Such persons, devoid of any sense of public duty, do however exist, and it would certainly be in the public interest to have them treated as rapidly as possible. In the United States such a policy is already in operation in at least one place.

A long-term policy in the public health aspects of syphilis must not be forgotten, for the sufferer from late effects such as general paralysis of the insane or cardiac disease may become a charge upon the State. We do not know what percentage of syphilitics treated by intensive methods may yet develop late phenomena. The aim in treatment is complete cure, and to accept any method which falls short of this, even if it offers immediate benefits in rapid and permanent surface sterilization in a high percentage of cases, may be to store up trouble for the future.

The aim in research into the treatment of syphilis is to discover a scheme which will occupy as short a time as possible, which will be free of dangerous toxic effects, give a high percentage of permanent 'cures', and can be used on out-patients. A clue has been given in the animal research work of Eagle and Hogan, who found that, within broad limits, the curative dose of 'Mapharside' with any one method of treatment was largely independent of the time period over which that treatment was given. Intravenous drip methods with 'Mapharside' were consistently less effective than repeated syringe injections over the same time periods. With regard to toxicity they found that on any schedule of injections the shorter the total treatment period the lower is the margin of safety. Assuming that these considerations apply in human syphilis, they have suggested a variety of possible schemes for trial. Patients are already being treated on the experimental lines suggested.

The treatment for early syphilis in the future may be a compromise between the present standard scheme and the intensive methods described above, and will probably last from four to ten weeks. The arsenical will almost certainly be an arsenoxide preparation injected by syringe at least three times a week, and bismuth will be used concurrently.

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OBITUARY

Dr. F. L. Pyman, F.R.S.

THE news of the death of Dr. Frank Lee Pyman on January 1 at the early age of sixty-one, after a prolonged illness, will have been received with deep regret by his many friends. Pyman was an outstanding personality in the chemical world of twentieth-century Britain, and his experimental work in medicinal chemistry has been a not inconsiderable factor in fostering the respect in which British medicinal chemistry is held to-day.

Pyman entered Owens College, Manchester, in 1899, and, after graduating in 1902, went to the Polytechnic at Zurich, where he had the good fortune to come under the influence of Bamberger, who was then at the zenith of his fame. The dissertation which followed was published in 1904, and Pyman was granted his doctorate at the University of Basle. In 1905, on his return to Great Britain, he obtained a post with T. E. Thorpe at the Government Laboratory, but stayed only a few months as he felt he had little flair for analytical chemistry.

Circumstances in another branch of chemistry were, however, propitious. The late Sir Henry Wellcome had for a decade pursued an enlightened policy of establishing laboratories for scientific research, and had allowed the results of such research to be published, a policy which, it is true to say, had ushered a new era into British pharmaceutical chemistry. In furthering this policy, Wellcome had in 1905 appointed Jowett, who had carried out noteworthy investigations under Power's directorship of the Wellcome Chemical Research Laboratories, as head of the new Experimental Department of the Wellcome Chemical Works at Dartford. Within a year, however, Jowett was raised to the position of works manager, and the vacancy thus created was filled by Pyman. This was indeed a fortunate choice, since, over the ensuing period of eight years, a succession of model papers issued from this laboratory under Pyman's name which stand comparison with any chemical work published in Great Britain during the same period. The subjects covered ranged from local anæsthetics, mydriatics and hypnotics to arsonic acids, *iso*quinoline alkaloids, glyoxalines and the alkaloids of jaborandi and ipecacuanha; they probably reached the height of experimental perfection in the syntheses of histamine and histidine, and in the elegant results obtained in the study of the Hofmann degradation of tetrahydroberberine methosalts.

In 1914 Power persuaded Wellcome to allow him to return to the United States, and it was but natural that Pyman should succeed to the directorship of the Wellcome Chemical Research Laboratories at Snow Hill, a position he held until early in 1919. The war years were strenuously devoted to the production of drugs hitherto made abroad and, in particular, the difficult problem of the salvarsans claimed much of Pyman's attention. In addition, the ipecacuanha alkaloids, so important in the treatment of dysentery, were made to reveal more of their secrets.

The war years were unsettling years; Pyman had long cherished the ambition of a professorial chair, and in 1919 this goal was realized when he accepted the post of professor of technological chemistry in the Municipal College of Technology, Manchester. He entered on his new teaching duties with zest; he was an excellent lecturer, and for eight years he directed the researches of numerous students, the main theme being the chemistry of the glyoxalines. As glyoxalines are cyclic amidines, Pyman extended his investigations into this field, and the amidines were the subject of constant research up to the time of his death. The full fruits of amidine chemistry in its application to therapeutics—in this Pyman was a pioneer in Great Britain—have still to be reaped.

In 1927 Pyman was appointed director of research to Boots Pure Drug Co., Ltd., at Nottingham, a position he occupied until his death. Administrative duties were now paramount, and he regretfully left the test-tube and allowed it to be wielded by others under his stimulating direction. During this period a return was made to the chemistry of glyoxalines, the glycerophosphates, and the *iso*quinoline alkaloids, but new departures took Pyman into the field of organic salts of bismuth, long-chain amines and amidines, purgatives and derivatives of harmine and harmaline; studies of all of which were enriched by his long and ripe experience.

In 1935 Pyman was fittingly awarded the Hanbury Medal of the Pharmaceutical Society for original research in the natural history and chemistry of drugs. He was chosen as president of Section B (Chemistry) of the British Association at Nottingham in 1937, and his address was devoted to an account of the extensive researches of his colleagues, on amœbicides in particular, and on antiseptics.

To the outside world, Pyman's published researches are a lasting memorial to his memory. His friends, colleagues and pupils will, in addition, remember him as an English gentleman, staunch and straight and in whom there was no guile. Widespread sympathy will be felt for his widow, his three sons and two daughters in their tragic bereavement.

HAROLD KING.

NEWS and VIEWS

Institution of Electrical Engineers

Faraday Medallist

THE Council of the Institution of Electrical Engineers has made the twenty-second award of the Faraday Medal to Dr. Irving Langmuir, associate-director of the Research Laboratory of the General Electric Company in Schenectady, N.Y., for his outstanding contributions to electrical science. Dr. Langmuir's investigations have ranged over an extremely broad field. His work on hard vacuum valves, thyratrons and gas-filled incandescent lamps is widely known. He has also worked on atomic hydrogen welding and carried out fundamental researches on oil films; this latter work led to clearer understanding of such diverse topics as thermionics, heterogeneous catalysis and surface tension. Dr. Langmuir was elected a foreign member of the Royal Society in 1935 (see NATURE, July 6, 1935, p. 14), and three years before he had been awarded a Nobel Prize for Chemistry. The Faraday Medal is awarded by the Council of the Institution of Electrical Engineers not more frequently than once a year, either for notable scientific or industrial achievement in electrical engineering or for conspicuous service rendered to the advancement of electrical science, without restriction as regards nationality, country of residence, or membership of the Institution.

Honorary Member

THE Council of the Institution of Electrical Engineers has elected Sir Ernest Thomas Fisk to be an honorary member of the Institution. This distinction has been conferred upon him in appreciation of the services he has rendered in Australasia in the field of radio-communications. Sir Ernest, who is a past-president of the Institution of Radio Engineers (Australia), was managing director from 1917, and has been chairman from 1937, of Amalgamated Wireless (Australia), and also chairman of several other companies concerned with wireless. Originally a member of the Marconi Company, he joined a special mission to the Arctic in 1909. He has generally pioneered radio in Australia, including direct wireless communication with Great Britain, having received the first direct wireless message from England to Australia in 1918. In 1940 Sir Ernest was appointed secretary of the Economic Cabinet in Australia, and Director of Economic Co-ordination.

Agricultural Education in Great Britain

THE Minister of Agriculture has announced the Government's plans concerning the future of agricultural education. So varied have been the reactions to the recommendations contained in the Luxmore Report that it was natural that the Government should require time to digest the different points of view before reaching a decision. Two matters have been determined. The first concerns the future of the provincial and county advisory services, which are to be unified into one national service for the whole country directly under the Minister of Agriculture, and financed entirely by the Exchequer. This is virtually one of the Luxmore proposals, though it should be noted it is the system which has governed county advisory work during the War. War Agricultural Executive Committees have assumed the full responsibility for this work, and the majority of county council staffs have been seconded to these committees, while considerable additions to technical staffs have been made direct. The provincial advisory service has always been financed by the Exchequer, but the new proposals will remove this work from the control of the provincial colleges and university departments of agriculture. One cannot see any serious drawbacks to these proposals and

they will be endorsed by the majority of those engaged in this work at present.

The second proposal concerns the farm institutes. These are to be multiplied in number, but the provision of agricultural education at the farm institute level and below will remain a function of the local authority. In this sense the Government has wisely accepted the criticisms levelled against the Luxmore proposals. Discussions have proceeded as to the control which should operate in the case of the farm institutes, and as a piece of permanent machinery a joint advisory committee is to be set up by the Ministry of Agriculture and the Board of Education to advise on the general educational policy and methods of training at farm institutes, and in turn the institutes will be inspected by inspectors of the Board of Education and of the Ministry of Agriculture. It is a pleasing thought that the Government is now recognizing that steps must be taken at an early date to make available farm institute training, since it has been little short of a national catastrophe that the existing institutes were closed down at the beginning of the War and educational work at this level has practically ceased. The explanation is that staffs normally engaged in this work were diverted to the needs of food production; but since there has been a considerable influx of new blood into agricultural education work directly concerned with food production since the beginning of the War, it should now be possible to provide adequate staff for the re-opening of farm institutes at an early date. This will be in the best interests both of food production and the future of agriculture itself in Great Britain.

Social Security in the United States

In the discussions on social security in Great Britain, it has already been emphasized that, at least in part, social security is an international problem. Full employment, or the reasonably high level of employment pre-supposed in the Beveridge plan, depends on the general condition of world trade as well as on the social and economic policies pursued internally in Great Britain. For that reason alone the article on "Social Security Planning in the United States", contributed by Eveline M. Burns to *Agenda* of December 1943, is of general interest. It gives an appreciation of the general situation in the United States and of the lines of development and policy recommended in the Security, Work and Relief Policies Report of the National Resources Planning Board, the Wagner Bill proposing to set up a unified national system of social insurance, and the more recent report of the Planning Board on "Demobilization and Readjustment", which shows the complexity of the situation in the United States.

Any acceptable and realistic programme for the United States must take account of the great geographical diversity in living standards and real wage levels, and must be so devised as to operate within the limitations of a federal system of government in which the consciousness of State rights is very strong. Furthermore, many sections of the public still regard government action to assure the basic economic security of the individual with the gravest suspicion. Social security planning of the type envisaged by the National Resources Planning Board meets with strong opposition among those who believe that the job can be done by private enterprise. Moreover, there has been a surprising lack of public interest in the proposals of the report on demobilization and readjustment, with its emphasis on the vital importance of efforts to assure full employment and on the responsibility of the Federal Government to announce its vitally important policies as soon as possible for both economic and social reasons. The whole psychological attitude of Americans, and the present boom, tend to conceal the inadequacy of American social machinery for grappling with the problems of poverty and insecurity; and no great national ordeal comparable to the 'blitz' in Great Britain has strengthened the sense of communal responsibility and the desire to remedy some of the glaring social evils of the pre-war world.

Planetaria of the World

Mr. Roy K. Marshall has an article on the Planetarium in *Sky and Telescope* of November 1943, which announces the first public demonstrations in the Fels Planetarium of the Franklin Institute in Philadelphia. The remainder of the article is devoted to a historical survey of the planetaria which have been constructed at various times, starting with Archimedes, the story of whose machine for reproducing the motions of the planets is probably legendary. The first of such machines to be made, of the quality of which we can be certain, was constructed by Johannes van Ceulen de la Haye, in 1682, and it is still preserved in Leyden. The proper way to represent the heavens is to make a celestial globe so large that the observer can get inside it, and the most famous of these is the one constructed about 1758 by Roger Long, the first Lowndean professor of astronomy and geometry at Cambridge. It was about 18 ft. in diameter and thirty people could be accommodated on the platform inside it.

A list of known planetaria with dates and also the diameters of the domes is given. Of twenty-seven planetaria, twelve are installed in Germany, the largest, with a diameter of 98 ft., being at Düsseldorf, and the United States comes next in the list with a total of six. A short description of some of the instruments and also diagrams appear, and the subject will be continued in a later issue. It may be mentioned, though it is probably known to most readers already, that the name 'orrery', which is frequently applied to these instruments, is derived from the fourth Earl of Orrery (Charles Boyle), for whom John Rowley made an instrument. This was an improvement on the model made by George Graham for Prince Eugene shortly after 1700.

An Attack on Logical Positivism

The simple solution to philosophical problems, which those philosophers who describe themselves as logical positivists have propounded in the last ten years, are to-day coming under attack. In the issue of *Mind* of October 1943, Mr. John R. Reid, who, like many American philosophers, uses a rather elaborate and top-heavy nomenclature, in his article "Analytic Statements in Semiosis" strikes hard at the root of logical positivism by attacking its account of the distinction between analytic and synthetic statements. Briefly, according to the logical positivists, an analytical statement, for example, "Red is a colour", asserts no matter of fact, cannot be denied without self-contradiction, and needs no verification; whereas a synthetic statement, such as "What I see now is red", states matter of fact, can be denied without self-contradiction, and needs to be verified. An analytical statement needs no verifica-

tion because it says nothing about anything; it merely illustrates our verbal habit. In saying "Red is a colour", I am merely illustrating the verbal habit we have of grouping the class of things we call *red* under a larger class which we call *coloured*. If, however, I say "What I now see is *red*", this is no question of verbal habits, but a matter of fact, and what makes it true or false is just what I *am* seeing now.

Mr. Reid argues that this is not the whole story, pleading that verification is needed even in the case of the analytic statement. What he says, reduced to very simple terms, is this: "Verbal habits are not known to me by any mysterious form of cognition. The analytic statement 'Red is a colour' must be verified by the same *sort* of process as the synthetic statement 'What I now see is red'. I must check how people do in fact use words such as *red* and *colour*. I must check just what my own use is (because it *is* my own use does not prevent me being ignorant about it) and what I intend my use to be. Rules of English change, and as they change, it may be expected that analytic statements will change with them." In Mr. Reid's view, then, both analytic and synthetic statements require to be verified, the former by the intentions and verbal habits of people, the latter by facts and natural laws. The point is one which was worth making though it may not reduce the structure of logical positivism to ruins.

Problems of Colonization

UNDER the title "Ideas Sobre Los Fundamentos Bioclimaticos Y Biogeographicos Para Una Colonizacion Europea", in *De Gœa, Anales de la Sociedad Argentina de Estudios Geográficos* (7, 99–111), Walter Knoche sets forth a number of important points to be observed if colonization is to be a success. As a general principle, it is laid down that woods and forests should be protected, as they are valuable in preserving the climate, to say nothing of their aesthetic value and their use to future generations in preventing the spread of steppe and desert. Problems relating to the acclimatization of European colonies in different latitudes are considered, and also the difference in the aptitude for acclimatization of European immigrants from southern Europe or from the Mediterranean countries in comparison with those from north-west and central Europe. It is interesting to know that in torrid zones no colonists from north and central Europe are found who have any real expectations for their descendants, but this does not apply to certain southern European colonists. The difficulties of acclimatization in torrid zones are discussed and also the effects of certain climatic conditions, such as ultra-violet light which acts very differently in regions of high altitude, in temperate zones, and in tropical countries. Very short waves produce erythema while those that are longer are responsible for the formation of pigment which, while it reflects some heat, also absorbs some and, as a consequence, there ensues hypertension of the sweat glands. The southern European is better protected against the solar radiation in torrid regions than is the northern European, though the latter is now able to acquire an artificial pigment by means of sun bathing or special heat rays. The principle laid down by the Incas is recommended: "Colonize in the valleys similar to those existing in the previous State, and other parts of the earth with temperature and conditions like those from which we came; if cold, select cold; if hot, select hot".

Bell Laboratories Photographic Department

PHOTOGRAPHY is a necessary part of research and development work, and there has been a Photographic Department at the Bell Laboratories, 463 West Street, New York, ever since the building was erected for the Western Electric Company at the close of the last century. Beginning with a single photographer and camera, it grew with the organization it served until in 1941 it required the full time of nine men, and included developing and printing quarters and a studio with cameras and other facilities that permitted it to turn out some 4,500 negatives and 63,000 prints each year. By this time the facilities were old and needed replacement. A careful study was therefore made of all needs and the most efficient production methods, and an entirely new lay-out was made, new equipment acquired, and all needed facilities provided to do the work most efficiently. This new lay-out was just about completed when war came, bringing with it intensified work, longer hours and increased personnel, and there is no doubt that the greatly augmented demands for photographic services of various types would have greatly exceeded the capacities of the old facilities. With the new quarters and equipment, a staff of fifteen is now producing at the rate of 14,000 negatives and nearly 200,000 prints a year. The new quarters are described and illustrated in an article by E. Van Horn (*Bell Lab. Rec.*, 22, No. 2; October 1943).

Conductor Sagging on Overhead Lines

Messrs. C. O. Boyse and N. G. Simpson recently read a paper in London on this subject before the Institution of Electrical Engineers, in which the first part reviews overhead-conductor sags and tensions and their calculation on single spans and on complete lines, using parabolic formulæ throughout. A standard procedure and standard methods of calculation are recommended. The second part of the paper deals with the determination, with respect to the conditions prevailing in Great Britain, of the wind and ice loads to be applied to conductors for design purposes, and the stresses so produced in the conductors. The use of the term 'factor of safety' applied to overhead conductors is criticized, and suggestions are offered for revision of the Overhead Line Regulations of the Electricity Commissioners. The loads transmitted to the supports are also considered. Erection sags for low-voltage distribution lines are recommended for general adoption.

Sheet Steels for Electrical Plant

A PAPER entitled "A Survey of Electrical Sheet Steels for Power Plant and the Factors Affecting their Magnetic Properties" (*J. Inst. Elect. Eng.*, **90**, Pt. II, No. 17; October 1943) by Mr. F. Brailsford discusses magnetic sheet materials used for electrical plant, and represents an attempt to stimulate the interest of electrical engineers and others in this class of sheet steels, in which progress in relation to the commercial materials has been relatively slow. After a short discussion of the historical development, the limitations imposed upon designers of electrical plant by the existing materials are referred to. This is followed by a brief outline of the physical basis of magnetic processes and by a discussion of the factors which affect the magnetic properties of electrical sheets. Finally, reference is made to future possibilities. The problems involved in

the production of better electrical sheet steels concern not only the practical steel-maker and the electrical engineer but also, for their solution, the physicist, the chemist and the experimental metallurgist. There is a great demand in the electrical industry for better electrical steels, particularly for transformers.

Lepidopterous Larvæ in Stored Products

WAR conditions have made it essential to know the numerous kinds of caterpillars, as well as of other insects, affecting stored food in Great Britain. It was soon found that with few exceptions the available descriptions of these larvæ are quite inadequate for identification purposes. Being based mainly on colour it became necessary to use more precise methods. In a useful paper entitled "The Larvæ of the Lepidoptera associated with Stored Products" (*Bull. Entomol. Res.*, 163; Oct. 1943) by Dr. H. E. Hinton of the British Museum (Natural History), the chætotaxy and other structural features are relied upon for distinguishing the species. He deals with thirty-five species which include all the more important British kinds, together with seven which have not yet been recorded in Britain. In order properly to study the structure and chætotaxy of the larvæ it is necessary to preserve them in Pampel's fluid or alcohol or other preservative; dried specimens have, as a rule, too many of the critical setæ missing. Through the early researches of Dyar, Forbes and Fracker, and more recently of certain European workers, the classification of Lepidopterous larvæ has been placed on a relatively sound basis, although much still remains to be done.

Tuberculosis Survey in the Western Pacific

A GRANT of £28,600 has been made under the Colonial Development and Welfare Act to enable a tuberculosis survey to be made in Fiji. It is hoped to extend the survey to the British Solomon Islands Protectorate and the Gilbert and Ellice Islands Colony. The scheme will cover a preliminary survey only, mainly to determine the extent of the problem and the best means of dealing with it. A Government medical officer is undertaking preliminary work. A comprehensive scheme for the reorganization of the medical services of Fiji and the Western Pacific with assistance under the Act is contemplated, under which it is proposed to provide accommodation for four hundred cases throughout the area.

Road Research

A COMMITTEE of the Road Research Board of the Department of Scientific and Industrial Research has been appointed "to survey the field for research on the use of machinery in road construction and, if thought fit, to draw up a programme of research". The Committee is constituted as follows: Sir George Burt, Mr. R. M. Wynne Edwards, Mr. A. Floyd, Mr. W. Minty, Mr. W. P. Robinson, Dr. W. H. Glanville (director of road research), and Mr. G. Bird (secretary).

The Department has also arranged to resume and extend its researches on concrete roads as part of the programme of the Road Research Board. The new work, which will have as its general aim the improvement of the standard of construction in respect of durability of surface characteristics, will be undertaken in co-operation with the Cement and Concrete Association. The Ministry of War Transport is co-operating in both these schemes.

Earthquake in Turkey

YET another large earthquake has taken place in Anatolia. On the morning of February 1, a strong earthquake occurred to the north-west of Ankara. The epicentre was near the town of Gerede, which is 180 miles east of Istanbul and about 60 miles from the Black Sea. In Gerede itself about four fifths of the houses were destroyed, and here and in the province of Bolu (in which Gerede is situated) 310 people were killed. In the province of Changiri 517 were killed, mostly at Tcherkesh, while in Zonguldak Province 25 people lost their lives. The effects of the shock were widespread, and in the villages north-west of Ankara 103 deaths as a result of the earthquake are reported. Altogether at least 955 people were killed by the earthquake and its effects, and some thousand others were injured. Faulting occurred along the motor-road from Ankara through Gerede and Bolu to Ismid, and communications were cut between Istanbul and the Kandili Observatory on the eastern shore of the Bosphorus. Snowstorms have hampered relief work. Strong tremors were felt at Adabazar, Ismid, Haidar Pasha, Smyrna, Kaisarieh and Brusa. The shock was registered at Kew Observatory in England at 4.28 a.m., the maximum ground movement at 4·41 a.m. being greater than one millimetre. This is the fourth great earthquake, besides numerous others of smaller intensity, which has occurred since what was probably the greatest Turkish earthquake—that of Erzinjan in December 1939.

Announcements

SIR HAROLD SPENCER JONES, Astronomer Royal, has been elected an honorary member of the American Astronomical Society.

DR. WILLIAM CULLEN, the distinguished consulting chemical and metallurgical engineer, has been elected president of the Science Masters' Association in succession to Prof. Frederick Soddy.

PROF. E. K. RIDEAL, professor of colloid science in the University of Cambridge, will succeed Mr. Wallace P. Cohoe, a well-known American consulting chemist, as president of the Society of Chemical Industry, at the annual meeting of the Society to be held in July.

PROF. P. M. S. BLACKETT, Langworthy professor of physics at the University of Manchester, has been elected president of the Association of Scientific Workers as from February 1. During the War, Prof. Blackett is working for the Admiralty; he is widely known for his work on nuclear physics and cosmic rays.

THE Council of the Institution of Electrical Engineers having sanctioned the formation of a Wireless Group for Cambridge and District, a provisional committee has been approved, under the chairmanship of Mr. C. R. Stoner, with Mr. D. I. Lawson as secretary. The inaugural meeting will be held in the Engineering Laboratories of the University on February 17.

THE A. Cressy Morrison Prize Committee for 1943 of the New York Academy of Sciences has awarded prizes of two hundred dollars each to W. A. Ritchie, Rochester Museum of Arts and Sciences, Rochester, N.Y., for a paper on "The Pre-Iroquoian Occupations of New York State", and to A. Grobman, University of Rochester, Rochester, N.Y., for a paper on "The Distribution of the Salamanders of the Genus Plethodon in Eastern United States and Canada".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Terminology of Nucleic Acids

So far as is known at present, nucleic acids are of two types, differentiation depending on the nature of the sugar which is present. In one type, the sugar is a pentose, and in those examples which have been sufficiently investigated, this pentose is *d*-ribose; the nitrogenous radicals are those of guanine, adenine, cytosine and uracil. In the other type, the sugar is a desoxypentose, and in those cases where examination has been adequate, this sugar is *d*-ribodesose, and the nitrogenous radicals are those of guanine, adenine, cytosine and thymine (5-methyl uracil). A convenient source of an acid of the former type is yeast, and the acid from that source became known as 'yeast nucleic acid'. Pentose nucleic acids were also thought to be peculiar to plants, and as a result the term 'plant nucleic acid' came into use, with an implication that all pentose nucleic acids from whatever source are identical; consequently the terms 'yeast nucleic acid' and 'plant nucleic acid' became synonymous. A satisfactory source of an acid of the second type is the thymus gland of animals, so that the acid from that source became known as 'thymonucleic acid'; and since it was believed that acids of this type were characteristic of animal tissues only, the term 'animal nucleic acid' came into vogue, with the implication that all nucleic acids of the desoxypentose type are identical. Thus the terms 'thymonucleic acid' and 'animal nucleic acid' became synonymous.

With the progress of knowledge it became clear that these generalizations were inaccurate, and it was suggested[1] that it is necessary to define a nucleic acid by referring both to its origin and its type. In this way alone, in the light of present information, is it possible to avoid future confusion, until such time as it can be stated with certainty either that two (or more) individual nucleic acids exist and that all examples of each are identical in chemical constitution, or that two (or more) types of nucleic acid exist and that each type comprises a number of examples of related but different constitutions.

Recently, however, Pollister and Mirsky[2] suggested that the names 'chromonucleic acid' and 'plasmonucleic acid' should be used by biologists to denote the nucleic acids called by chemists 'desoxyribose nucleic acid' and 'ribose nucleic acid' respectively. It seems to us that this suggestion has little to recommend it, and is, in fact, retrograde.

The adoption of these terms would be open to the objections based on constitutional reasons mentioned below, and their application to denote the two types of nucleic acid, pentose and desoxypentose, would not clarify the present situation, and would merely replace names based on chemical structure or biological source by other terms not wholly accurate because based on an incorrect statement of biological distribution. Thus, Pollister and Mirsky state that "it is now clear that desoxyribose nucleic acid is normally restricted to the chromatin of the cell nucleus", and that it is "now certain that the ribose nucleic acid, by contrast, is found either in the cell cytoplasm or in the plasmosome (nucleolus) of the cell nucleus". This statement is barely tenable at the present time without special emphasis of the word 'normally', since it is known, for example, that the viruses of psittacosis and vaccinia[3] contain desoxypentose nucleic acid and that the magnesium salt of ribonucleic acid forms part of the surface structure of Gram-positive organisms[4]. Who can predict what the future may bring in the way of other exceptions to Pollister and Mirsky's basis of definition?

Further, Pollister and Mirsky's proposed classification is founded on the recognition of certain chemical units detected only after the disintegration of complex molecules which occur in a considerable variety of biological sources. It ignores entirely in what ways those units may be joined together. There is at present no evidence to show whether the nucleotide components are united in the same mode and pattern in the different examples of each of the two types of nucleic acids, that is, that such examples have, in fact, identical chemical constitutions. The adoption by biologists of Pollister and Mirsky's proposed classification would obscure potential differences, which if they exist cannot fail to be significant.

It seems necessary, therefore, to reiterate the suggestion made more than five years ago that, until the position becomes clearer, a nucleic acid should be defined by reference to its origin and type (pentose or desoxypentose); closer specification of the type, for example, *d*-ribose or *d*-ribodesose, is to be welcomed when justified on sound chemical grounds.

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Nottingham. Jan. 10.

[1] Gulland, J. M., *J. Chem Soc*, 1722 (1938).
[2] Pollister, A. W., and Mirsky, A. E., NATURE, **152**, 692 (1943).
[3] Hoagland, C. L., Lavin, G. I., Smadel, J. E., and Rivers, T. M., *J. Expt. Med.*, **72**, 139 (1940).
[4] Henry H., and Stacey, M., NATURE, **151**, 671 (1943).

Vitamin A Aldehyde

WITH reference to Dr. Morton's suggestion regarding the role of vitamin A aldehyde (axerophthal) in the chemical changes involved in photo-reception[1], it may be of interest to mention that we prepared this substance some eighteen months ago by Oppenauer oxidation of vitamin A alcohol with aluminium *iso*propoxide in the presence of acetaldehyde. The ultra-violet absorption spectrum of the aldehyde showed maxima at 350 and 368 mμ in *cyclo*hexane and a band at 657 mμ in the antimony trichloride reaction, and was characterized by the formation of a 2:4-dinitrophenylhydrazone, m.p. 207–209°. On Pondorff reduction, it regenerated vitamin A alcohol (abs. max. at 330 mμ in the ultra-violet and at 620 mμ in the antimony trichloride reaction) which was characterized by conversion into 'cyclized' vitamin A (abs. bands at 390, 370 and 350 mμ in the ultra-violet and at 620 mμ in the antimony trichloride reaction). On condensation with acetone in the presence of sodium ethoxide, the aldehyde furnished axerophthylideneacetone[2].

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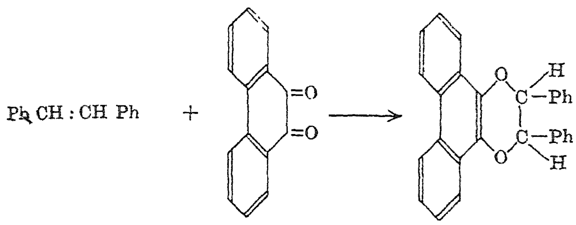
[1] NATURE, **153**, 69 (1944).
[2] Batty, Burawoy, Harper, Heilbron and Jones, *J. Chem. Soc.*, 135 (1938).

Reactions of Ethylenes with 1,2-Diketones in Sunlight

WE have found that ethylenes, for example, styrene, stilbene and triphenyl ethylene, react with 1,2-diketones when dissolved in benzene (thiophene-free) and exposed to sunlight. The experiments were carried out in 'Monax' glass tubes in an atmosphere of carbon dioxide. The reaction between phenanthraquinone and stilbene, which proceeds very rapidly, may be illustrated by the following scheme :



The nature of the product (m.p. about 260° with decomposition) is established by the fact that the photo-product is colourless (therefore no longer having the quinoid structure of phenanthraquinone) and when heated above the melting point, it decomposes into phenanthraquinone and stilbene. The action of concentrated sulphuric acid on it yields phenanthraquinone.

A full report describing the wide scope of the reactions mentioned in the title will be published soon.

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Topography of a Quartz Crystal Face

IN a recent communication[1] a brief description was given of a multiple-beam interference method which can reveal submicroscopic detail upon the surfaces of crystals, and some preliminary data for cleavage faces of mica and selenite were recorded. This method has now been applied to reveal the topographical

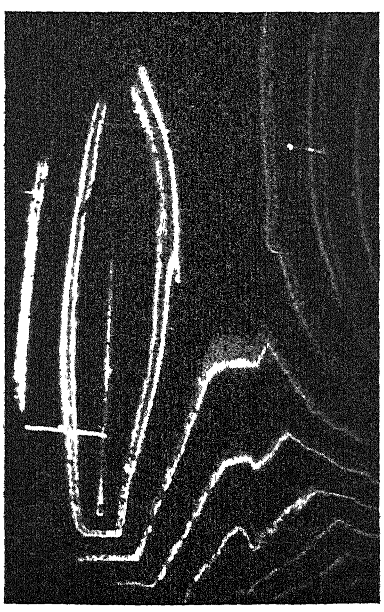

FIG. 1. Transmission fringes.

FIG. 2 Reflexion fringes

features of a highly lustrous (100) face of a left-handed quartz crystal. Typical interference contours for this face are shown in Figs. 1 and 2. The particular pattern recorded in any exposure is determined by the angle of inclination between the interference surfaces, and the contour patterns, although superficially different, give the same interpretation of surface structure when this is taken into account.

Fig. 1 shows *transmission* fringes over the larger part of the (100) face, the optical conditions being such as to prevent the whole of the face being covered. Both green and yellow mercury fringes appear. Fig. 2 shows *reflexion* fringes of the same face (green only), with a different inclination between the interference surfaces. The fringes are remarkably sharp, particularly those in reflexion, and the precision is so high that faces with angles of no more than 1/50 of a minute of arc between their normals can be measured. This is true even for quite small facets, and, of course, far exceeds the Rayleigh diffraction limit of the goniometer.

The interference contours reveal considerable detail, and each kink and bend in the fringes has true topographical significance and can be interpreted accordingly. The patterns show the existence of a small number of large vicinal faces covering the entire (100) face. These are inclined to each other at very small angles varying from 0·50′ to 9·00′. Furthermore, the surfaces of these vicinal faces are in most cases slightly curved, with radii of curvature varying from 60 to 20 metres. In some cases the ridge formed by the junction of two vicinal faces has not a constant angle but exhibits considerable, but continuous, variation along the ridge length.

The visual markings characteristic of a (100) face in quartz, namely, fine striations, inverted V markings and small triangular patterns, each show their own influence upon the interference pattern, and their topographical features have been determined. The striations have been found to be either minute ridges or ruts, the height (depth) being only 100 A. (that is, 20 molecules). Both ridges and ruts have been observed. The inverted *V* markings reveal small discontinuities in level in their immediate neighbourhood, of the order of small fractions of a wave. The triangular markings are found to be small submicroscopic projections, which are tetrahedra, some 450 A. in height (that is, 90 molecules), and with vicinal face angles of the order of 2′ or 3′.

The perfection of the reflected system of fringes shows that the experimental procedure employed can be applied widely to include all types of crystals with moderately large approximately plane surfaces. Translucent, opaque, and in fact metallic crystals or even crystal aggregates, as well as transparent crystals, can be studied, and it is clear that the procedure opens up considerable possibilities. The optical adjustment in reflexion is no more difficult than in transmission, and the photographic speed is increased by a factor of about 30. Fig. 1 required a 1-minute exposure, Fig. 2 required 2 seconds. (The magnifications of the figures are not quite identical.)

Complete details concerning the experimental arrangements, which are critical, together with the complete topographical analysis of the crystal face, have been communicated elsewhere.

It may indeed be considered that this procedure functions in a region intermediate between that available to study by X-rays and by the microscope respectively.

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[1] NATURE, 152, 722 (1943).

Ascorbic Acid and Hip Fertility in Rosa Species

PREPARATIONS rich in vitamin C made from the flesh of ripe Rosa receptacles are now being produced on an industrial scale, in Sweden as well as in other countries. The systematic examination of native and cultivated species of Rosa has shown that considerable differences occur in their content of ascorbic acid. One of the present authors (J. S.) published in 1941 a paper on the results obtained at Kärnbolaget AB, Stockholm, up to that year. In that publication the chemical methods used were described in considerable detail, as was also the relation of ascorbic acid to yearly fluctuations, chromosome number and taxonomical position. Previously, Gustafsson[1,2] and Gustafsson and Håkansson[3] were engaged in genetical and cytological experiments on *canina* roses and undertook in 1942, with the financial support of Kärnbolaget AB, a population analysis of ascorbic acid in the roses of south Sweden. By this joint work a relation was discovered that seems to be of general importance, namely, the influence of hip fertility on the amount of ascorbic acid.

Successful cross-experiments were carried out in 1932 and 1934 between various *R. canina*, *rubiginosa* and *rugosa* biotypes. Especially the hybrid series *R. canina* II × *rubiginosa* and its reciprocal have proved interesting in several respects and have been carefully studied with regard to ascorbic acid content. With *R. canina* as mother the hybrids form large hips, rich in ascorbic acid ; but at the same time containing very few fruit, that is, they are largely infertile. Most of the reciprocal hybrids, with *R. rubiginosa* as mother, give late-ripening, bottle-shaped hips, having a low content of ascorbic acid, but being normally fertile with a high number of nuts per hip. These reciprocal differences made us assume that the infertility is responsible for the high content of ascorbic acid, or, in other words, that the fewer nuts per hip, the more ascorbic acid, within similar hybrid series and in related species. The proof this assumption was afforded by a monosomic plant in the *R. rubiginosa* × *canina* II series (Pl. 34), this having a low fertility owing to the loss of one chromosome (34 instead of 35), but simultaneously a highly increased vitamin C content. The results are given in Table 1.

TABLE 1

	Ascorbic acid as per cent dry matter of the flesh		Nut content as per cent of the hip weight	
	1941	1943	1941	1943
R. canina	1 9	2 7 , 2 4	27	31 ; 32
R. rubiginosa	3 0	3·3 , 3·4	24	33 , 32
R. canina × *rubiginosa*				
Pl. 1	3·9 , 4 6	4 1 ; 4 1 · 3 9	11 ; 13	11 ; 16 , 10
Pl. 2	4·4	4 3 , 4 0 ; 4 4	9	13 ; 10 ; 11
Pl. 3	—	4 1 , 3 9	—	12 ; 12
Pl. 4	5 1	3·9 ; 4 9 ; 4 3	12	10 , 11 ; 9
Pl. 5	—	3 9 , 5·0 ; 4 2	—	8 ; 8 , 8
Pl. 6	—	4·2 , 4 1	—	16 , 15
R. rubiginosa × *canina*				
Pl 1	2 2	—	44	—
Pl. 4	2 0	—	49	—
Pl. 21	—	2 8	—	35
Pl. 51	—	2·1	—	44
Pl 34 ($2n=34$)	5 1	4 6 , 4·2	21	27 , 22

(The analyses of *R. canina* I × *rugosa* and *R. canina* II × *rugosa* run in the same direction, but so far the content of ascorbic acid in the *R. rugosa* parent has not been sufficiently determined to allow definite conclusions.)

This negative correlation of hip fertility and content of ascorbic acid was also demonstrated in three other sets of material.

In 1942 the ascorbic acid and the nut content were determined in 155 different spontaneous *R. canina* individuals, the hips of which were collected by Gustafsson and then immediately examined. Most of the shrubs belonged to the *R. eucanina* and *afzeliana* complexes (Case 1).

Similarly, a series of samples were taken by Schröderheim[4] from 41 different parcels delivered for industrial production in 1943 from various parts of south and middle Sweden (Case 2).

In these two cases the material was biologically heterogeneous. In order to examine the corresponding conditions in one and the same species, samples of 164 *R. rugosa* individuals grown at Närlunda, not far from Stockholm, were analysed. Owing to the heterozygosity of this species in Nature most of the individual shrubs probably represent different biotypes, but every one falls within the boundaries of the species (Case 3).

The *P*-values were determined by analysis of the co-variance[5,6]. The data obtained are given in Table 2. The regression is expressed in such a way that the coefficient, −0·037, to exemplify from Case 1, implies an *increase* by 0·037 per cent in ascorbic acid content for every 1 per cent *decrease* in fruit content.

TABLE 2.

	Average fruit content in per cent of hip weight	Average ascorbic acid in per cent dry matter of hip flesh	Corr. coeff.	Regr. coeff	*P*
Case 1	34·76	2·82	−0·21	−0·037	0 01–0·001
Case 2	31·63	2·50	−0·75	−0·120	<0 001
Case 3	20·82	3·50	−0·17	−0·032	0·02

Consequently, the fertility of the hips shows an obvious and significant influence on the amount of ascorbic acid. This fact in its turn may signify that the ascorbic acid (or some sort of precursor or derivative) takes direct part in the seed and nut development, so that it is stored up in the receptacles and not consumed if for some cause (genotypically or environmentally conditioned) the nuts are few in number and the ascorbic acid is not needed in metabolism.

These results point to a reconsideration of the connexion between chromosome number and vitamin C content in apples, tomatoes and other fruits[7,8]. Especially in apples, where the fruit is false and constructed in a similar way to the rose receptacle, we may conceive that the higher vitamin C content of triploids as compared with that of the diploids is due to the infertility itself, as well as to the chromosome number and the genotype.

Finally, it ought to be stressed that for the full ripening of a Rosa receptacle only one or two fruits are required. In fact, the above-mentioned *R. canina* ♀ × *rubiginosa* ♂ hybrids flower and fruit abundantly, although the number of fruits per hip is very low.

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[2] Gustafsson, Å., *Hereditas* (in preparation, 1944).
[3] Gustafsson, Å., and Håkansson, A., *Bot. Not* (Lund 1942).
[4] Schroderheim, J., *Kungl Fys. Sällsk. Handl.*, **52**, No. 9 (Lund, 1941).
[5] Fisher, R. A., "Statistical Methods for Research Workers", 6th Ed (Edinburgh, 1936).
[6] Bonnier, G., and Tedin, O., "Biologisk variationsanalys" (Stockholm, 1940).
[7] Darlington, C. D., NATURE, **150**, 404 (1942).
[8] Melville, R., and Pyke, M., NATURE, **150**, 574 (1942).

Manganese Deficiency in Oats

E. S. TWYMAN[1] stresses the value of the water-culture technique used by Stout and Arnon[2] in investigations into the effects of traces of the heavy metals on plant growth. The demonstration of the rapidity with which grey-speck lesions can be produced in oat seedlings is, however, not new, and directs attention to the need to consider carefully the chemical background to all water-culture investigations. More than fifteen years ago it was shown[3,4] that, provided proper precautions were taken to exclude manganese from the culture solutions, grey-speck lesions invariably developed in oat plants in four weeks or less. Recent work by Arnon and Stout[5] on the effect of molybdenum on the growth of tomatoes has been confirmed by me[6] in regard to oats, so that the response obtained by Twyman to the group of seven elements (aluminium, molybdenum, titanium, vanadium, tungsten, nickel and cobalt) cannot be separated from the response known to be due to one of them.

In all critical water-culture investigations, it is necessary to consider carefully the chemistry of the elements under investigation, so as to appreciate the possible sources of contamination by them, the effective means for their removal, and specific tests to demonstrate their absence. Thus, in the case of investigations into manganese deficiency, it can be shown that water from a well-designed tinned-copper still and block tin condenser is entirely satisfactory, although such water would not be in the least suitable for investigations into the effects of copper and certain other heavy metals on plant-growth. For this, water redistilled from all-glass apparatus is essential. Water from a tinned-copper still has been found to contain 20–80 μgm. of copper per litre, depending on the condition of the tin coating of the still. In many cases high-grade analytical reagents can be shown to be free from manganese while other reagents, such as magnesium sulphate and iron salts, almost invariably require specially devised methods for their purification from the last traces of manganese. Fortunately, many of the methods for the removal of this element will, when properly carried out, also eliminate the last traces of copper, zinc and certain other heavy metals. Not all these methods will be equally effective for the removal of molybdenum, which exists as the molybdate ion in alkaline solutions, or for non-metallic elements such as boron. Incidentally, the diphenylthiocarbazone test does not detect either of these elements, and it is not correct to assume that methods suitable for the elimination of a particular element, or group of elements, will also ensure general purification of the reagents from all other important trace elements.

Traces of manganese and zinc are readily obtained by plants from many types of glass ordinarily used for culture vessels. In critical experiments involving these elements, it is therefore necessary to protect the surface with paraffin wax, or preferably to use vessels of 'Pyrex' glass. Many of the better quality resistant glasses do not yield significant traces of copper to plants growing in vessels made from them, hence they are quite suitable for such investigations.

In many experiments the amounts of the trace elements contained in the seed must not be overlooked for, after satisfactory control of all reagents and water has been obtained, these amounts become of prime importance. It is often necessary to select seed as low as possible in the element under investigation. The natural variation may be very considerable; I have noted a range of 10–75 mgm. of manganese per kgm. of dry matter and 0·9–11·3 mgm. of copper per kgm. for Algerian oats. Other investigators have also found considerable variation in seeds generally. Experiments recently carried out by me indicate that the relatively greater amounts of copper contained in rye grain account for the greater growth made by this plant when oats and rye are grown under identical conditions in nutrient solutions, either in the absence of copper or in the presence of amounts of the order of 1–2 μgm. per litre.

If adequate means of chemical control had been available to, or attempted by, the early investigators of the trace elements, to ensure the purity of the water and reagents used and the suitability of the glass of the culture vessels, it is reasonable to assume that the essential nature of manganese, boron, copper, zinc, and molybdenum would have been demonstrated many years sooner.

C. S. PIPER.

Waite Agricultural Research Institute,
University of Adelaide.
Nov. 3.

[1] Twyman, NATURE, **152**, 216 (1943).
[2] Stout and Arnon, *Amer. J. Bot.*, **26**, 144 (1939).
[3] Samuel and Piper, *J. Agric. South Australia*, **31**, 696 and 789 (1928).
[4] Samuel and Piper, *Ann. Appl. Biol.*, **16**, 493 (1929).
[5] Arnon and Stout, *Plant Physiol.*, **14**, 599 (1938).
[6] Piper, *J. Aust. Inst. Agric. Sci.*, **6**, 162 (1940).

MR. PIPER has rather missed the point of my communication, which was to direct attention to the value of the Arnon technique, since this, so far as I was aware, had not until then been used in Great Britain. I exemplified this value by quoting some of my own experiments with oats. I certainly did not wish to suggest that there was anything new in producing the symptoms of grey-speck disease in water culture, and I had assumed that all those interested would be well acquainted with the work of Samuel and Piper, published some fifteen years ago, since it was this work which established the proof of the connexion between grey-speck disease and manganese deficiency.

With regard to the effect of molybdenum on the growth of oats, I would say that I have now been able to read Mr. Piper's paper which, probably owing to war conditions, had not reached me at the time of the publication of my earlier letter. There is now no doubt that molybdenum is an essential element for the growth of oats. It still remains to be proved, however, whether one or more of the other elements of Arnon's original *B*7 group (chromium, titanium, vanadium, tungsten, nickel and cobalt) were also responsible for at least part of the response obtained in the experiment reported in my communication.

I would like to take this opportunity of correcting an error made in my letter where I included aluminium among the seven elements of the *B*7 group; this should have been chromium. Thus for aluminium read chromium in Mr. Piper's letter in this issue.

E. S. TWYMAN.

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Development of Botanical Investigations at Rothamsted

IN an article in NATURE of July 24 entitled "Development of Botanical Investigations at Rothamsted", the following statement is made with reference to 'minor' elements and plant growth[1]:

"Stimulation with minute traces of elements was far more difficult to demonstrate, though some indication was obtained. Following up an accidental clue obtained in 1921, Dr. K. Warington proved conclusively that in the absence of a trace of boron, growth of broad beans was completely checked. . . ."

I am not sure what constitutes an "accidental clue" in scientific investigations, but as a matter of historical interest in the progress of our knowledge about the effects produced by minute quantities of boron on the growth of broad beans, attention might be directed to the following statement made by Dr. Warington in the introduction to her classical paper published in 1923[2].

"In some experiments carried out by Dr. J. Davidson at Rothamsted in 1920 in connection with the bean aphis, broad bean plants in water culture solution supplied with a small quantity of boric acid were strikingly superior to the rest of the series; accordingly, the present investigation was undertaken in order to determine more fully the action of boric acid on the broad bean and certain other plants."

The experiments referred to formed part of a wide programme of research, which aimed at finding out by means of controlled experiments with the black aphis on broad beans "whether changes can be introduced in the sap of the growing plant, so as to affect its suitability as food for the aphids, and at the same time not adversely affect the plant"[3].

JAMES DAVIDSON.

Waite Agricultural Research Institute,
University of Adelaide.

[1] NATURE, 152, 91 (1943).
[2] Warington, K., *Ann. Bot.*, 27, 631 (1923).
[3] Davidson, J., *Ann. Appl. Biol.*, 12, 494 (1925).

The British Elm Flora

THE view expressed by Howard in his interesting article on the elm tree[1], that there are but two species represented in the United Kingdom "with perhaps nine or more hybrids or varieties", is no longer accepted by botanists. It is true that the common or English elm and the wych elm are the most widely-spread species and both are undoubtedly native. The wych elm, the correct name for which is *Ulmus glabra* Huds., occurs throughout the country, but the common elm is concentrated in the south, thins out in northern England and is probably only planted in Scotland. This species is now known as *U. procera* Salisbury, the Linnean name *U. campestris* being a *nomen ambiguum*[2]. Its distribution in the country is quite natural, and so far it has been recorded from the Continent only as a planted tree; the evidence strongly favours the view that it is endemic, in spite of the misgivings of earlier writers.

The parts of England to the south and east of a line drawn from the Bristol Channel to the Humber has an unusually rich elm flora, including several species that appear to be endemic, though their status cannot be finally settled until a critical examination has been made of the elms of the neighbouring parts of the Continent. The Cornish elm, *U. stricta* Lindley, is abundant in Cornwall and Devon, thins out eastward into Dorset and is represented by a variety, the Goodyear elm, var. *Goodyeri* Melville[3], to the south of the New Forest, and by a further variety, the Wheatley or Jersey elm, var. *sarniensis* (Loud.) Moss, in the Channel Islands and possibly adjacent parts of France. The three varieties form a geographical series or topocline increasing in breadth of leaf from west to east[4]. In low-lying parts of the river valleys, from the Wash across to the Severn, is found the most distinctive and elegant of our endemic species, the Plot elm, *U. Plotii* Druce[5]. The Continental smooth-leaved elm, *U. carpinifolia* Gleditsch (*U. nitens* Moench), is doubtfully native, but we have instead the East Anglian elm, *U. diversifolia* Melville[6], having shoots with symmetrical leaves interspersed with others bearing the usual lop-sided leaves and another species with intergrading varieties extending across the Midlands and East Anglia. The latter awaits description, as does the small-leaved elm of East Anglia related to the Plot elm.

The Dutch elm, × *U. hollandica* Mill. var. *major* (Sm.) Rehd. and the Huntingdon elm, × *U. hollandica* var. *vegeta* (Loud.) Rehd., are widely planted; both are presumed to be hybrids of the wych elm with *U. carpinifolia* Gleditsch. There are numerous natural hybrids; the wych elm apparently hybridizes freely with all the other species except *U. procera*, which normally has finished flowering before the wych elm starts. It is probable that many of the hybrids are fertile, as intergrading series of hybrid forms connect the species. The intergrades are particularly numerous between *U. glabra* and *U. Plotii* and may be arranged in sequences on leaf shape

characters[7]. Horwood's Midland elm, *U. elegantissima*, is a hybrid of this group.

There is a wide field for investigation in the physical properties and economic value of our native elms. Much of the ill-repute with which elm timber is regarded may be due to admixture of unsuitable hybrids. Without botanical assistance both forester and timber merchant may accept inferior hybrids as wych elm, since the habit of this species appears to be a dominant character. Field observations suggest that interaction or recombination of genes occurs in the hybrids, and may result in wood so brittle that branches half an inch in diameter break under slight pressure with a short fracture. On the other hand, it is probable that improved strains for timber production could be selected and this might be coupled with resistance to the Dutch elm disease, *Ceratostomella ulmi*. Of our native species, the wych elm is the most susceptible, but some of its hybrids are even less resistant, notably the Dutch elm and many of the heterogeneous forms hitherto imported as seedlings from the Continent. The Cornish elm, the English elm and the Plot elm all appear to be comparatively resistant.

R. MELVILLE.

Royal Botanic Gardens,
Kew.

[1] Howard, A. L., NATURE, **152**, 636 (1943).
[2] Melville, R., *J. Bot.*, **76**, 261 (1938).
[3] Melville, R., *J. Bot.*, **76**, 185 (1938).
[4] Melville, R., *Proc. Linn. Soc.*, **151**, 152 (1939).
[5] Melville, R., *J. Bot.*, **78**, 181 (1940).
[6] Melville, R., *J. Bot.*, **77**, 138 (1939)

SURELY Dr. Melville is misquoting me. My statement was: "There are about twenty species, of which only two are prominent in the United Kingdom —the common elm (*Ulmus campestris*) and the wych elm (*Ulmus montana*)—with perhaps nine or more hybrids or varieties".

The article contributed by Dr. Melville, who has made a comprehensive study of the elm tree and has published many interesting articles in the *Journal of Botany* and that of the Linnean Society, recalls to my mind a conversation which took place about forty-two years ago between Henry John Elwes and Sir Hugh Beevor, one of whom at the time was president of the Royal English Arboricultural Society. The subject was whether the elm was indigenous to Great Britain, and covered much the same ground as that traversed by Melville. It seems difficult to understand that those keen-eyed, closely observant men who came before and followed Evelyn would be likely to have been mistaken. The intelligent woodman clearly recognizes the difference between the common elm, the wych elm and the Dutch, the last-named of which assumes a quite different appearance in its habits from either of the others.

There is no doubt that the elm, with the exception of those sorts already mentioned, and possibly the Cornish elm, varies greatly, probably more than any other of our trees.

The regular planting and rearing of English elm has received little attention during the last two hundred years, and the greater majority of those trees that have established themselves have been self-sown. During this period a great many aliens have been introduced into Great Britain—American, Canadian, European, Japanese, etc. Is it possible that this has resulted in the development of hybrids ?

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An Undescribed Feature in the Drill (*Mandrillus leucophaeus*)

GLANDULAR modifications of the skin over the sternal region in primates have been described in the orang (Schultz) and in the Gelada. Something of the kind evidently exists in the drill (*Mandrillus leucophæus*) and possibly also, therefore, in the mandrill (*M. sphinx*), though full details cannot be given pending histological study of the part. No reference is made to such a structure by Sonntag.

My notice was first directed to the possibility of a sternal cutaneous modification in a male drill which has been in captivity under my observation for seven years. After passing the pubertal epoch at the approximate age of five years, he developed, upon the middle of his chest, between the nipples, a tuft-like patch of specialized hairs. These are longer, coarser, stiffer and of duskier colour than the general ventral covering of short, soft, whitish hairs. They project caudalwards and at times are slightly more upstanding than the hairs of the neighbouring areas.

This hairy tuft is the basis of a very curious and extremely amusing behavioural pattern which is observed *only* when the animal is presented with pieces of fresh twig or bark derived from a mango tree (*Mangifera indica*). After smelling the twig, he rubs it in a vertical direction on his mouth and chin (maximum pressure being on the chin) and swiftly passes it thence to the sternal tuft, thrusting the chest forwards to meet it. This procedure is repeated many times in rapid succession. Each time a return is made from sternum to lips, profuse salivation takes place, until his beard is literally dribbling with saliva, much of which is transferred to the sternal tuft in the frenzied antics accompanying the act. The animal apparently realizes that this behaviour has an entertainment value, and this stimulates him to adopt the most inconceivable bodily postures in an endeavour to obtain the maximum number of contacts between the twig and his chest in the minimum time. The animal is quite rational in his other behaviour, so that I do not consider this to be merely a personal idiosyncrasy.

No adequate explanation can at present be offered for this behaviour; but it is clearly initiated by the characteristic odour of the mango bark (the fruit has no similar effect). Some pleasurable sensation is evidently experienced either (*a*) from contact between the moistened bark and the sternal tuft, or (*b*) the twig serves to transfer a possible cutaneous secretion from a gland on the chest to the lips and nose, whereby pleasure is evoked by the taste or smell thereof, or (*c*) both.

There is no direct evidence of any sexual significance in the specialization here referred to, except that so far it has only been observed in an adult male. I have examined cadavers of two female drills (one juvenile and one sub-adult) and found no modification of the hair, and at any rate no macroscopic indication of a cutaneous gland in the intermammary area. The matter is being further investigated.

W. C. OSMAN HILL.

Faculty of Medicine,
University of Ceylon,
Colombo.
Nov. 25.

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Wislocki, G. B., and Schultz, A. H., *J. of Mammalogy*, **6**, 236 (1925).

REGIONAL PLANNING AND RESEARCH IN THE UNITED STATES

IN the field of industrial research, the United States of America have always and with very good reason been held up as an impressive example; and a remarkable illustration of this truth now comes in a recent report on New England*. It is the more timely and interesting since it deals also with regional planning and location of industry in close relation to research.

New England comprises the six comparatively small States of Maine, Vermont, New Hampshire, Massachusetts, Connecticut and Rhode Island; accounting for only 2 per cent of the total land areas of the United States, but contributing 8·6 per cent to the country's manufacturing industry, and employing 12·1 per cent of the wage earners. There is no need at this time to describe in any detail the manifold industries and the spirit of enterprise and courageous and intelligent self-help which distinguishes its people: the point of main interest is the energy and vision with which New England is dealing with present and prospective problems of industry and social life, and its very faithful application of research methods to regional development.

Regional planning in this section of the United States may be said to date back to 1925, when the New England Council was established to co-ordinate economic interests and act in a broad sense as a research agency, both in the technical and the social aspect. It is democratically based on individual and corporate representation, and its one aim is to advance the economic and cultural welfare of the six States. One of its first actions was to set up a research committee, when Lincoln Filene—a great name in American industrial history—was appointed chairman. It initiated complete surveys of industry and technical research facilities, investigated cultural and recreational development, agricultural well-being, community growth, and in a word the whole field of communal and industrial activity.

In 1938 the president of the Council approached the Massachusetts Institute of Technology and asked the Institute to assist in the setting up of a New Products Committee. This assistance was readily forthcoming, and four sub-committees were soon afterwards established. (1) "Research Day" in New England, which aimed at setting apart one day at least in the year when all New Englanders should think about research and its vital importance to their welfare; become, in fact, research-minded. Meetings would be held, papers read, and speakers invited to tell the people in plain language some of the latest achievements of science. Special efforts would be made to interest the smaller firms, and discover means whereby they too should benefit from technological advance. (2) Natural Resources, to undertake complete surveys. (3) New Manufactures, mainly to study the various materials and products imported into New England, with the view of determining which of these could well be produced within the regional borders. Purchasing agents' associations were called in to help, and many new lines of industry were thus indicated, including fibre glass textiles and the like. At first sight it would seem that New England might benefit at the expense of other parts of the United States if this policy should be largely followed; but this is not necessarily the case, for manufacturers of these products in other parts would be invited and encouraged to establish branches in New England.

(4) Venture Capital. This sub-committee is of particular interest. As the name implies, its function is to finance the new ventures, and by skilful publicity, based on the many real advantages offered by New England to investors, to attract capital from outside and encourage those within the region to put their money into local industries rather than into safe gilt-edged securities. Hitherto brains and capital are said to have been the principal exports, but now it is earnestly sought to retain both at home for investment there. If other regional units of the United States follow the New England example, then there would be keen rivalry among them in attracting industrial enterprise, including capital, labour, research workers and management. Assuming that such competition is desirable if properly controlled and guided in the national interest, then it constitutes the real kernel in the location of industry problem.

Several interesting questions arise here of vital national and international importance as to the right kind of competition and its judicious balance with co-operation. It is obviously undesirable that one region within a country should gain at the expense of others, just as it is for one country to gain at the expense of others. These difficulties cannot be discussed fully here, but so far as New England is concerned, it is held that the most important part of the work of the Council is survey and research in order to ascertain quite definitely what are the determining factors involved in the question: Where shall we locate our business? In New England, in the Middle West, in some other part of the United States, or abroad? The last-named possibility should not be overlooked by taxation authorities, by labour leaders and others. It was indeed suggested early in the history of the Council that a permanent organization should be established to study industrial opportunities which offer the chance of major development, and assemble full and complete factual information on which industrial leaders could base a sound and intelligent judgment. Small firms would be welcomed equally with large.

Accordingly a Research Foundation was set up in 1941—the New England Industrial Research Foundation Incorp.—with a small operating staff and trustees of management. The seventeen founders were carefully selected to represent the most varied interests throughout the six States. Funds were readily forthcoming, and these, together with the fees payable to the Foundation for the various services it would render, were held to be ample to keep the establishment going. Its main function, as already implied, would be social and industrial research, in no wise competing with existing technical or scientific research institutions. Special care was exercised in the appointment of the first director, in March 1942, and the choice fell on Dr. Lawrence W. Bass, who has had wide experience both in the Mellon and in the Rockefeller Institutes. On the New England "Research Day" held in Boston during May 1942, Dr. Bass emphasized the need for technical excellence as the New England slogan, achieved through the sheer power of intelligence in manufacturing operations exercised through labour, management and research.

W. G. L. C.

* The McGraw-Hill Book Company, Inc., 1943. 25 cents. See also *Chem. and Metall. Industry* (Sept. 1943).

THE FOREST RESEARCH INSTITUTE, DEHRA DUN

IN a Dispatch of the Governor-General in Council, India (dated Nov. 1, 1862), which merits a closer study than some parts of the Empire and Commonwealth appear to have given it, the formation of an Indian Forest Service with an inspector-general of forests at its head as adviser to the Governor-General was advocated, in order to check the excessive exploitment and waste of the forests of that country, which had been greatly intensified with the increased demand following the establishment of ordered rule, and to reserve and conserve selected forest areas. In sanctioning the proposals, the Secretary of State for India wrote that whereas capital expenditure might and would be justifiably spent in ameliorating ruined forests and in opening out inaccessible ones, he was assured that the work projected would result in a valuable forest estate accruing, which in due course, in addition to being of the greatest benefit to the people, would bring in an increasing revenue to the Government. This inspired prophecy was abundantly fulfilled.

Yet, something more than half a century later, so incalculable is the potential value of the great forest estate in India, that the Government of India wrote (to the Secretary of State), "the greater part of our Forest properties are undeveloped". The subject then in question was research and the Forest Research Institute at Dehra Dun. This was inaugurated in 1906, a research building erected and opened in 1912 and soon after came the War of 1914–18. Imports of many material products in common use in India came to an end, and the young Research Institute was called upon to investigate the possibility of replacing them with raw materials from the forests. The success achieved is common history. The second Dispatch, from which the above sentence is quoted, proceeds to point out that the existing research buildings were totally inadequate to the demands of the Institute and proposed, in addition to considerable increases of the research staff, the purchase of a site of 1,200 acres and the erection of a new Institute building, workshops, residencies, etc., at an estimated cost of close on a million pounds sterling. This great scheme was sanctioned by the Secretary of State, and the new Institute building was opened some seven years later by the Viceroy.

Once again war supervened ; and once again India was faced with a closure of imports and the necessity of falling back on her own resources. For the second time the Forest Research Institute, now immensely stronger, has proved able to give invaluable services.

A recent publication, "Forest Research in India and Burma, 1941–42. Part I. The Forest Research Institute" (Dehra Dun : Forest Research Institute, 1943. Pp. iv+151. 1*s* 11*d*.), summarizes some of the work carried out. "Even more than last year," says the writer, "the work of the Institute has been dictated by War, in fact in certain sections and branches practically all work on ordinary programmes has been suspended to deal with war research. Whilst the branches dealing with Sylviculture, Botany, Mycology, Chemistry and Entomology have only dealt, in most cases, more or less indirectly with war problems, though their assistance has been solicited on occasion, the brunt of the work has fallen, as was the case during the last War, on the Utilization Branch, which throughout has had to devote its whole time to war work."

During the year this branch has been continuously evolving substitutes for which there was a shortage for one reason or another as a result of the War. In conjunction with the Mechanical Section, the Wood Working Section has devoted its energies entirely to the demands of India and the Army. Containers of many types down to the ordinary pail, and for a variety of purposes, were constructed of plywood, on the basis of researches at the Institute, and were afterwards manufactured at factories. The Wood Technology Section spent the year identifying timbers mostly for the Army, but was also concerned with the selection of the right type of timber for aircraft. It also trained in timber identification sixty men of the Ordnance and Military Engineers Services Departments. Ammunition boxes, walnut wood for rifles and other researches were undertaken by the Timber Testing Section ; while the Seasoning Section advised on the installation of kilns in various parts of India and also developed a simple hot-air kiln for quickly completing the seasoning of partially air-dried half-wroughts for such material as tool helves, shuttles, bobbins, picker-arms, etc. Unseasoned wood is useless for many of these purposes. The Adhesives for Plywood investigations have been already alluded to (NATURE, Jan. 29, p. 144). The Paper Pulp Section continued to work throughout the year, guided to a large extent by the Advisory Committee of the Indian Paper Makers' Association, there being a general shortage of paper in the country.

Some interesting research in the Chemistry Branch, carried out owing to war shortage, included a simplified method of preparing ephedrine and its salts from Indian Ephedras. This has been started on a factory scale, so that ephedrine salts are now being produced to replace the imported article. Retorts have been installed, as a result of experimental work, for the large-scale distillation of chir (*Pinus longifolia*) tar ; the perfected process in these retorts will now yield products not only suitable for use in rope and rubber works but also for medicinal purposes. Tamarind seeds were shown to be a cheap source of pectin. A large amount of work was also carried out on charcoal for producer gas.

Truly has the great value and usefulness of her forests to India in times of stress, as in those of peace, justified the foresight of that Secretary of State in the distant days of 1862.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public.)*

Saturday, February 12

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 2.30 p.m.—Dr. G. Jessop : "Some Electro-chemical Methods of Analysis".

Monday, February 14

FARMERS' CLUB (at the Royal Empire Society, Craven Street, London, W.C.2), at 2.30 p.m.—Mr. A. P. McDougall : "Increasing the Cattle Population".

ILLUMINATING ENGINEERING SOCIETY (at the Royal Institution, Albemarle Street, London, W.1), at 5 p.m.—Dr. H. Buckley : "Some 18th Century Contributions to Photometry and Illuminating Engineering".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Major R. C. Farrow : "Surveys for Power in the Coast Range of British Columbia".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. Frank Parfett : Presidential Address.

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre Swiss Cottage, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.15 p.m.—Dr. E. Spencer : "Coal as a Source of Chemicals".

Tuesday, February 15

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Bernard Bourdillon, G.C.M.G.: "Nigeria To-day".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. J. Ramsbottom: "Fungi and Modern Affairs", i. "Fungi as Food and Poison".*

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Recording and Reproduction of Sound" (to be opened by Dr. G. F. Dutton).

Wednesday, February 16

BRITISH PSYCHOLOGICAL SOCIETY (SOCIAL PSYCHOLOGY SECTION) (at Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2 p.m.—Mr. H. J. Eysenck: "Three Methods for Studying National Differences in Sense of Humour"; Marie Jahoda: "Some Difficulties in Participant Observation"; Mr. Otto Friedmann: "Some Problems of Political Propaganda".

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2 p.m.—Discussion on "The Limitations and Uses of the Comparative Method in Medicine", 3: "Nutrition and Endocrinology" (to be opened by Dr. H. H. Green and Dr. S. J. Folley).

NEWCOMEN SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. Robert S Nilssen: "The Pioneer Period of the Development of the Arithmometer from Pascal, 1642, Polenie, Leibnitz and others up to 1821, when the first Commercial Machine was Manufactured by Charles X. Thomas of Colmar".*

SOCIETY OF CHEMICAL INDUSTRY (MICROBIOLOGICAL PANEL OF THE FOOD GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. T. F. West: "The Pyrethrins and the Role of Pyrethrum in the Anti-Pest Measures".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers.

ROYAL INSTITUTE OF CHEMISTRY (LONDON AND SOUTH-EASTERN COUNTIES SECTION) (at 30 Russell Square, London, W.C.1), at 5 p.m.—Dr. B. A. Southgate: "Recent Advances in Treatment of Sewage and Trade Waste Waters".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Discussion on "Television Standards" (to be opened by Mr. L. H. Bedford and Mr. W. A. Beatty).

Thursday, February 17

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. A. J. Ewins, F.R.S.: "Chemotherapy in Tropical Medicine".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Lawrence Bragg, F.R.S.: "The Strategy and Tactics of Crystal Structure Analysis by X-Rays".*

KING'S COLLEGE (in the Department of Electrical Engineering, Strand, London, W.C.2), at 3 p.m.—Mr. N. V. Castling: "Electrical Switchgear".*

INSTITUTION OF ELECTRICAL ENGINEERS (CAMBRIDGE WIRELESS GROUP) (in the Engineering Laboratories, The University, Cambridge), at 8 p.m.—Inaugural meeting. Mr. T. E. Goldup: "The General Aspects of Radio Engineering Progress".*

Friday, February 18

ASSOCIATION OF APPLIED BIOLOGISTS (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 11.30 a.m.—Annual General Meeting. At 12 noon—Discussion on "The Organisation of the Agricultural and Horticultural Advisory Services in Great Britain, with Special Reference to the Recommendations in the Luxmoore Report" (to be opened by Prof. W. B. Brierley).

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5 p.m.—Annual General Meeting. Mr. H. A. Hepburn: "Fencing of Dangerous Parts of Machinery".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Miss Olga Tufnell: "The Wellcome-Marston Excavations at Lachish".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mr. R. T. D. Fitzgerald: "Nigeria and Reactions to the War".

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION, joint meeting with the TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. B. S. Golds and Mr. C. L. Lipman: "A Modern Earth-Fault Relay Equipment for Use on Systems protected by Petersen Coils".

Saturday, February 19

BRITISH ASSOCIATION OF CHEMISTS (at the Café Royal, Regent Street, London, W.1), at 2.30 p.m.—Twenty-sixth Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ENGINEERING LECTURER (Ref. No. C.1997A), MATHEMATICS LECTURER (Ref. No. A.422A), PHYSICS LECTURER (Ref. No. A.423A), ASSISTANT MATHEMATICS AND PHYSICS LECTURER (Ref. No. A.424A), ENGINEERING INSTRUCTOR (Ref. No. O/N.391), and a DEMONSTRATOR to assist lecturers in class work generally (Ref. No. O/N.392), for the Technical School of a Government Department located in Surrey—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Ref. No.) (February 16).

MASTER FOR MATHEMATICS AND SCIENCE in the Junior Technical School—The Clerk to the Governors, North-East Essex Technical College and School of Art, Colchester (February 17).

MASTER OR MISTRESS TO TEACH BIOLOGY and assist with some ELEMENTARY SCIENCE OR MATHEMATICS—Mr. E. B. Stockdale, Education Office, Mexborough, Yorks. (February 19).

WATER ENGINEER AND MANAGER of the Corporation of Dundee Water Department—The Town Clerk, City Chambers, Dundee (February 19).

TEACHER OF ELECTRICAL ENGINEERING SUBJECTS, and a TEACHER OF MECHANICAL ENGINEERING SUBJECTS, at the Smethwick Municipal College—The Chief Education Officer, Education Offices, 215 High Street, Smethwick 41 (February 21).

CHAIR OF BOTANY tenable at King's College, and CHAIR OF BOTANY tenable at Birkbeck College—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (February 21).

ASSISTANT ENGINEER for the Sudan Government Railways—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.783A) (February 23).

FIRST-CLASS MECHANICAL AND ELECTRICAL ENGINEER to act in the capacity of Plant Manager or Works Engineer (headquarters in the London area)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No C.2025XA) (February 23).

LECTURER IN CHEMISTRY FOR MEDICAL STUDENTS—The Acting Secretary, University Court, Glasgow (February 25).

DIRECTOR OF THE IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, Government of India—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C. (quoting Reference No. O.N.F. 2080A) (March 1).

UNIVERSITY CHAIR OF ANATOMY tenable at St. Mary's Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 20).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

LECTURER IN PHYSICS (man or woman, honours graduate)—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

WORKS MANAGER for Heavy Engineering firm in West Scotland—The Ministry of Labour and National Service, Appointments Office, 52 Robertson Street, Glasgow, C2 (quoting Reference No. 1105).

ASSISTANT MASTER FOR ENGINEERING SUBJECTS—The Principal, Technical Institute, Gravesend.

LECTURER IN GARDENING for Edgehill and Bingley Training Colleges—The Principals, at the Training College, Bingley, Yorks.

ASSISTANT LECTURER (temporary) in AGRICULTURAL CHEMISTRY—The Registrar, The University, Reading.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Reform of the Calendar: a Measure of Social Security. By Colonel Clifford Allchin Gill. Pp. 36. (Reigate: Ancient House Bookshop.) 1s. [121

Scottish Education Department. Training for Citizenship: a Report of the Advisory Council on Education in Scotland. (Cmd. 6495.) Pp. 28. (Edinburgh and London: H.M. Stationery Office.) 6d. net. [121

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Thirty-sixth Annual Report, 1942–43, presented by the Council to the Court of Governors on 22nd October 1943. Pp. 32. (Cardiff: National Museum of Wales.) [121

Empire Cotton Growing Corporation. A Review of the Work of the Experiment Stations, Seasons 1939–40 to 1941–42. By W. Nowell. Pp. iii+30. (London: Empire Cotton Growing Corporation.) 2s. [141

A New System of English Naming for British Macrolepidoptera By Beowulf A. Cooper and A. F. O'Farrell. Pp. 24. (London: Amateur Entomologists' Society.) 2s. 6d. [171

Colonial Office: Advisory Committee on Education in the Colonies. Mass Education in African Society. (Colonial No. 186.) Pp. 64. (London: H.M. Stationery Office.) 1s. net. [171

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 165: Potato Virus X.; Mixtures of Strains and the Leaf Area and Yield of Infected Potatoes. By Dr. J. G. Bald. Pp. 32. (Melbourne: Government Printer.) [61

Twenty-fifth Annual Report of the National Research Council of Canada, 1941–42. (N.R.C. No. 1089.) Pp. 33. (Ottawa: National Research Council of Canada.) [

Harvard Meteorological Studies. No. 7: Filter Measurements of Solar Radiation at Blue Hill Observatory. By Edmund Schulman. Pp. 68. (Milton, Mass.: Blue Hill Observatory.) 90 cents. [141

Thomas Jefferson and the Scientific Trends of his Time. By Charles A. Browne. (Chronica Botanica Reprints, No. 1.) Pp. 64. (Waltham, Mass.: Chronica Botanica Co.; London: Wm. Dawson and Sons, Ltd.) [141

Catalogues

Sotheran's Price Current of Literature, No. 872: Annotated Catalogue of Works on Medicine, Surgery and Pharmacology. (Medical Series, No. 4.) Pp. 76. (London: Henry Sotheran, Ltd.)

Ogal Drum-reading Plunger-type Colorimeter. Pp. 60. (Salisbury: The Tintometer, Ltd.)

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LIBRARY RESOURCES OF GREAT BRITAIN

AN important chapter in the McColvin report on the Public Library System of Great Britain dealing with co-operation, specialization and national projects emphasized the urgent need for a thorough and realistic survey of the whole field of special and non-public libraries. Such a survey, Mr. McColvin urged, would disclose a wealth of material which is not fully recognized and utilized, and would stimulate co-operation both between non-public libraries themselves and between non-public and public libraries. It is a necessary preliminary to a sound organization and development of the specialized resources of the nation.

This view was endorsed at subsequent discussions on the rehabilitation of European special library and information services during the Conference last September of the Association of Special Libraries and Information Bureaux, and the importance of such a survey has since been urged by Mr. G. Woledge, librarian of Queen's University, Belfast (see NATURE, Dec. 11, p. 687). A good deal of attention is being given to this question by the University and Research Section of the Library Association, which is considering the publication of a report on the post-war development of university and research libraries as a complement to the McColvin Report. The rehabilitation position, coupled with the problem which may well confront all libraries in completing after the War their broken and interrupted series of scientific and technical periodicals, will certainly enforce some attempt to plan systematically the distribution of available resources. Moreover, without some measure of co-operation, any efficient distribution of the book resources of Great Britain in view of present publishing difficulties is well-nigh impossible.

The basis for any such efforts must clearly be a survey of existing collections in all forms of special libraries, within and without the public library system of Great Britain, the functions they serve and their relation to the general needs of the country. The first step before any such inquiry can well be initiated is clearly to determine its scope, and on this point discussion of the proposal can most profitably at present settle. In such discussion, however, it is necessary to have a clear idea of the nature and extent of existing university and research libraries, their resources and the services they render, the form of present library co-operation, and the needs of the users of such libraries and the services they are entitled to expect.

In regard to the last, Mr. Woledge has already indicated some essential points. In an adequate system, both special libraries and special collections in general libraries will be required ; also reference collections and collections for loan. The geographical accessibility of reference collections must be considered, and the provision of the shelf access which is more easily supplied in a separately organized special library or department than in a section of a general library. Again, in addition to shelf-arrangements

which facilitate 'browsing', the collection and arrangement of ancillary material such as cuttings, off-prints, photographs, with all that is implied therein in the way of expert and specialized staff, must receive attention. Whether regarded from the point of view of an information system, the stimulation of creative thought or general education, the system must provide for the needs of the general reader as well as the specialist and research worker.

It is not, of course, suggested that the university and research libraries of Great Britain are not already, in themselves and through the system of voluntary co-operation developed in the last twenty-five years, already making most valuable contributions in such ways in supplying the material required for the advancement of knowledge. The problem is to determine whether the present extremely heterogeneous units, differing widely in age and size, could be knit to the general advantage into some more formal or informal structure. That need not affect the independent status of the individual libraries, to which some will attribute much of their present sense of responsibility, or the voluntary character of the existing system of co-operation. Under present conditions the individual libraries can scarcely continue to render the most efficient service to their own special clientele, and expend to the best advantage their available resources, unless regard is had to their position in the national system and the help which they might receive from, and give to, other libraries.

The university libraries are the properties of the bodies they exist to serve, and the interests of those bodies have naturally a first claim on their services. Almost without exception, however, they have recognized that part of the service which a university owes to its community is to make available, within the limits of its means and to those qualified to make use of them, such of its resources as are not available elsewhere and are not needed for its daily work. They have been glad to welcome outside readers and to lend their books to other libraries, and the contribution thus made to the advancement of knowledge is by no means insignificant.

The so-called 'special' libraries are also the property of various kinds of corporate bodies—local and national learned, scientific and professional societies, government departments, research associations, industrial and commercial firms, newspapers, etc. Although such libraries need feel even less obligation than the university libraries to the general public, their resources have been increasingly made available, if not generally, at least to other libraries whether special or public. Frequently they are the only source of supply of much specialized literature, and their co-operation in the national organization for inter-library lending through the National Central Library has been far more important than any statistics could show.

Besides these, there is a further group of government libraries the primary obligations of which are to the public in general; it should be unnecessary to say anything here about the importance of the British Museum as a reference library, or of the Science Library as a source of scientific periodicals for loan. The great municipal reference libraries, although in most ways associated more closely with the work of the public lending libraries than with that of other research libraries, are none the less an important part of the country's resources for research, and beside all these groups there is the National Central Library the organizing work of which has facilitated the full utilization of their resources.

No organization which leaves any of these groups out of account can claim to make anything like full use of Great Britain's library resources. A national scheme must provide for their voluntary participation on a national as well as on a local and regional basis. Given such co-operation, there should be no inherent difficulty in the allocation of public funds to provide for the strengthening or maintenance of any particular special collection which might be desirable in the public interest as a result of the proposed survey.

Without minimizing the importance of adequate staffing and housing of libraries, both special and general collections, or of efficient administration, the most urgent need is that of a survey of actual book resources as a basis for framing policy. An administrative survey is undoubtedly needed, but whether it should, as Mr. McColvin appears to imply, be combined with the urgently needed survey of the contents of libraries, may be questioned. Both are large projects, but they demand different qualifications in those responsible for carrying out the survey. Administrative reform, it is true, might sometimes be required before a special library could co-operate effectively, but that can scarcely apply to the appraisement of its holdings in the survey.

Much material for the survey of book resources in Great Britain is no doubt already in the possession of the National Central Library and of the Association of Special Libraries and Information Bureaux. The co-operation of both these bodies may be expected, but most of the present material will require re-examination. It is not enough in framing a policy merely to know of the existence of a special collection; information as to how far it is complete, how fully it is kept up to date, how far books are available for loan and in non-lending collections, and how adequately it is organized, is essential. The survey should bring out the weaknesses as well as the strength of the book resources of Great Britain.

There are other questions as to the extent of the survey which require determination. One is the inclusion or exclusion of local collections, most of which form part of the public library service and often in very small libraries. It may well be decid to leave manuscripts and theses to a subseque survey. Questions with regard to periodicals will probably arise, and the survey can be no more than a first step in the co-operative selection of periodicals, though it should assist the allocation of 'runs' where insufficient copies are available.

On the basis of such a survey, it should be possible to frame a policy which could be based on agreed principles, and to decide which collections could be most profitably developed in general and on what

lines. It would enable libraries to plan the development of their special collections, and though much more will remain to be done, such a survey is almost an essential preliminary to the co-operative purchase of periodicals.

The first objective in such a policy must clearly be the establishment of one full collection in a single library, such as is provided for many subjects by the British Museum and other great general libraries. No system of inter-library lending can take the place, for certain types of research, of a library where any reasonable demand can be satisfied at short notice. It is best that such a library should not lend its books, or at least do so sparingly, but Mr. F. C. Francis's paper on the British Museum as a special library, read at the autumn conference of the Association of Special Libraries and Information Bureaux, gives some idea of the problems that must be faced in attaining even this objective. We cannot assess the value and completeness of special libraries for this purpose without regard to the amount of material contained in more general works or series.

On the other hand, it is not so essential that the second objective, a full collection of books available for inter-library loan, should be in one library. Further development of the co-operation in this field which has been so marked in the last twenty years may be expected, chiefly on the lines of further specialization related to individual and to general needs, in the medium-sized general libraries, mainly reference libraries and university libraries. It may well prove that the greatest need for financial assistance is in this field.

The third objective should be a full collection, which may or may not be identical with one of the collections already mentioned, allowing access to the shelves and suitably arranged for that purpose. The importance of open-shelf libraries properly arranged so as to provide for and even encourage 'browsing' is often overlooked. The value of such 'browsing' in stimulating thought during research has been repeatedly demonstrated, and the special libraries and information departments might consider whether the re-arrangement of their material so as to permit free access to public material at least on the part of their own staff would not be worth while. Apart from that internal advantage, it might facilitate fuller participation in inter-library lending, though as Mr. McColvin has emphasized in his report, one of the objectives of a carefully planned policy should be to provide books where they are most wanted and thus reduce inter-library loans to a minimum.

The mere size of the great general libraries of Great Britain tends to preclude the supervision and shelf-arrangement necessary for open access collections of this type, and this function may fall to the special libraries or information departments. Again, every subject needs the provision of books in each of these three ways, though the relative importance will vary from subject to subject. For some subjects, more than one full non-lending collection may be required; overlapping or duplication must be considered in no narrow spirit. Questions of local as opposed to national book provision would rightly be disregarded by the survey, which none the less must examine the desirability of ensuring that certain large classes of literature, which cannot, and should not, be repeated in all libraries, exist in duplicate or triplicate for inter-library loan.

If any such survey is to be initiated in time for its results to be available when the replanning of libraries and replenishment of stocks become possible, it is imperative that it should be set on foot without undue delay. As a first step, the question of the scope of the inquiry and survey requires immediate consideration, and in this the views not only of librarians but also of users of libraries are alike important. The goodwill of all concerned in furthering the co-operation, which has been such a feature of the inter-war period, and in building up a network of special libraries and special collections in general libraries so as to cover the whole field of knowledge, or in the co-operative collection so far as possible of particular items such as periodicals, will be essential. Nor should its importance be overlooked by scientific institutions, to whom the housing of their existing libraries, as Sir Henry Dale indicated in his presidential address to the Royal Society, is already a matter of concern, and it should be assured of the warm support of all those who recognize that plans for the expansion of the universities must include generous provision for the libraries, both books and buildings.

AN INTERNATIONAL LANGUAGE

(1) Basic English and Its Uses

By I. A. Richards. Pp. 127. (London: Kegan Paul and Co. Ltd., 1943.) 3*s*. 6*d*. net.

(2) Basic for Science

By C. K. Ogden. (Psyche Miniatures, General Series No. 95.) Pp. ix+314. (London: Kegan Paul and Co. Ltd., 1942.) 3*s*. 6*d*. net.

LAST September, when Mr. Winston Churchill received an honorary degree from the oldest of American universities, he spoke of the common task awaiting our two peoples in the service of mankind. Himself the son of an English father and an American mother, and a supreme master of our common tongue, he did not see why we should not try to spread the use of our language even more widely over the globe. He went on:

"Some months ago I persuaded the British Cabinet to set up a Committee of Ministers to study and report on Basic English. Here you have a plan. There are others, but here you have a carefully wrought plan for an international language capable of very wide transactions of practical business and of interchange of ideas. . . . What was my delight when, the other evening, quite unexpectedly, I heard the President of the United States suddenly speak of the merits of Basic English . . . Harvard has done more than any other American university to promote the extension of Basic English. The first work on Basic English was written by two Englishmen, Ivor Richards, now of Harvard, and Ogden, of Cambridge University, England, working in association."

The latest works by Ivor Richards and C. K

Ogden treat of the uses of Basic English for the advancement of science. This is indeed the main theme of Mr. Ogden's book, which is written in Basic. Dr. Richards' volume has a wider scope. Like Mr. Churchill in his Harvard speech, Dr. Richards is chiefly concerned with the world's need of some means of international communication for the transaction of practical business, the interchange of ideas, and the spread of normal English. He argues with much force that national aggression is the outcome of spiritual separation, because sentiments of exclusive loyalty to the group, or of disloyalty to the planet, plunge us into wars; that the need for a common language will be greater than ever when the post-war world is linked up by the aeroplanes of to-morrow, by world-wide controls of many kinds—sanitary, economic, commercial—and by a universal demand for information and news; and that a world inevitably made one by its physical communications will destroy itself unless it can be united also through intellectual and moral communications.

If, then, in addition to its national tongues and its local vernaculars, the post-war world is going to need some common means of international communication, what is it to be? Dr. Richards gives his reasons for believing that no artificial language will meet the case and concludes that, "If there is to be a common language it must be a simplified, but not denatured, form of one of the world's existing major languages". Dr. Richards examines the question which of these languages is best suited to the task. He decides in favour of English, not merely because it is most widely used already, but also because there are good reasons for its prevalence. For example, despite the handicap of its appalling spelling, it can be made easier than any other language for learners in general.

The work on Basic English begun by Ogden and Richards in Cambridge during the 1920's and continued in many countries—particularly in the United States with the help of the Rockefeller Foundation—has aimed at discovering how English may best be learnt through a limited vocabulary in such a way that, if the process is interrupted at an early stage, the work already done may provide an auxiliary means of international communication of very wide use, and so that, if the learning is continued beyond that stage, there will be nothing to unlearn.

This "Basic English is English made simple by limiting the number of its words to 850 and by cutting down the rules for using them to the smallest necessary for the clear statement of ideas. And this is done without change in the normal order and behaviour of these words in everyday English. This is the first point to make clear. Basic English, though it has only 850 words, is still normal English. It is limited in its words and its rules, but it keeps to the regular forms of English. And though it is designed to give the learner as little trouble as possible, it is no more strange to the eyes of my readers than these lines", by Dr. Richards, "which are in fact in Basic English".

Much of Dr. Richards' book is concerned with the teaching of English to foreigners, particularly in China, with Basic as the first stage of the process. While insisting that Basic is no adequate substitute for a mastery of literary English, he holds that a sound knowledge of it is a better and more attainable goal than a more impressive programme that, in fact, leaves many a student without any serviceable command of the language. He adds that anyone whose native language is English will find that a few hours' study and practice are enough to enable him to travel, shop, visit and do the daily routine of business in Basic.

Dr. Richards found that, in China, the main incentive to learn English is interest in what is most distinctive about the West, its science. Much of the language of science is already international. Basic seeks to fill the gaps. A beginning has been made with a "Basic Science Library, a programme of science in Basic designed for the general reader, the learner of English, and the teaching of science in schools".

Mr. Ogden's little volume, "Basic for Science", gives many examples of the uses of Basic for popular exposition—including a fascinating extract from J. B. S. Haldane's writings on the sizes of animals—as well as for abstracts of original research. It is to be hoped that it may soon become the general practice for research abstracts to be written in Basic so that they may be more widely read all over the world. Meanwhile, Mr. Ogden's book provides scientific workers with an invaluable model for writing their papers and presenting their results in Basic English.

MAXWELL GARNETT.

HISTORICAL ANALYSIS OF ARCHÆOLOGICAL METHOD

The Three Ages

An Essay on Archæological Method. By Dr. Glyn E. Daniel. Pp. 60. (Cambridge: At the University Press, 1943.) 3*s*. 6*d*. net.

THIS concise, learned but lucid memoir deserves study not only by all archæologists, but especially by other men of science who have occasion to refer to archæological results but normally consult those large text-books that use the three-age system in the old misleading manner. It is really a critical historical analysis of archæological method, written by a representative of the brilliant younger generation of prehistorians now on active service. The author brings out ten important points.

(1) A workable system of classification being the indispensable condition for reducing any branch of empirical knowledge to a science, the adoption about 1818 by C. J. Thomsen of Copenhagen of the division into Stone, Bronze and Iron Ages marks the beginning of scientific archæology. (2) Thomsen adopted this system for the arrangement of museum specimens collected in a single geographical province, Denmark, and (3) on the strength of empirical observation, not of *a priori* theories. (4) Since its publication in 1836 it has been found, again empirically, applicable to material from other regions, but *only in Europe, the Near East, and Asia*. (5) With the accumulation of material it became possible and necessary to subdivide the Ages; the Stone Age has been split into Palæolithic and Neolithic since 1865, and these and the remaining Ages have since been subdivided in their turn. To these smaller subdivisions early investigators, following geological precedents (for example, Cambrian), gave names derived from type sites; de Mortillet's terms—Chellean, Acheulian, etc.—and Tischler's—Hallstatt and La Tène—are still occasionally used for such subdivisions of the Palæolithic and Iron Ages respectively, with confusing consequences. For (6) even within, say, the Stone Age of so small an

area as France or Denmark we have now to recognize a plurality of distinct but parallel and contemporary 'cultures' here defined as "significant and persistent associated assemblages of artefacts".

(7) The progress of prehistory has been retarded by the accident that the same names or the same sort of names (for example, Aurignacian, Hallstatt) have been given to assemblages of both types. In reality, the concept of 'culture' introduced a basis of classification quite distinct from the serial or chronological one underlying Thomsen's scheme; for the association of artefacts is due not only as in the latter to contemporary use, but rather to sociological, economic and in a word historical factors. (8) The three-age scheme was put forward as representing, and stratigraphically proved to represent, a chronological succession of technological stages in Denmark's prehistory. Less modest and less intelligent disciples took Thomsen's Ages as equivalent to periods of absolute time like the eras of geology. It has cost a lot of trouble to get rid of this erroneous deduction.

(9) To correct such abuses Daniel proposes some very reasonable and hopeful changes in classificatory terminology: (*a*) Names from type sites (Acheulian, La Tène) or even derived from type objects (like "Separate Grave"—his other examples, Chatelperronian and Gravettian, are in fact derived from French sites) should be reserved for the cultural classification (point 6). (*b*) Position in the serial classification, relative or absolute chronology, should be denoted by numbers or letters; in a footnote the author instances the use of numbered 'periods' in my "Prehistoric Communities of the British Isles", published since the memoir was written. He very properly condemns the practice of two of his most brilliant contemporaries who use terms like 'Neolithic A' and 'Iron Age B' to denote cultures without exclusively serial connotation. His complaint that Clark uses "Mesolithic I" where he should write "Holocene I" is, however less legitimate, since "Holocene I" should be applicable to the whole world, while Clark's division purports to apply only to Northern Europe. Prehistory is likely to be burdened for a long time with purely local sequences that must be distinguished by some qualifying adjective quite free from any suggestion of œcumenical significance.

(10) As a consequence, Thomsen's scheme can now be abandoned. It provided an indispensable scaffolding, but now distorts the structure. To be scientifically valid, a classification must use features that are not only well defined and easily recognized, but also significant and symptomatic of wider relations. The author sympathetically reviews recent attempts to give stadial significance to the Ages by equating them with decisive stages in the economic development of societies. The equations of the Palæolithic and Mesolithic Ages on one hand, and the Neolithic on the other, with the food-gathering and food-producing economies respectively of Elliot Smith would, he admits, achieve this result; but some food-gatherers, around the east Baltic for example, used a formally Neolithic equipment of polished axes, pottery, etc. My own attempts to give a comparable economic significance to the Bronze and Iron Ages are rejected. The urban revolution leading to civilization does not, of course, coincide with either of these Ages. But elsewhere I hope to have opportunity to set forth the concrete evidence that induces me still to maintain that the regular use of cast copper or bronze, and afterwards the substitution therefor of cheaper iron, had such far-reaching technological, economic and sociological consequences that they must rank as defining really distinctive stages in the development of even barbarian societies. Daniel himself suggests that a more significant division would be to bracket the Neolithic and Early to Middle Bronze Ages together as an "Eochalcic Age", and to let a "Full Metal Age" begin with the Late Bronze Age and extend over the whole prehistoric Iron Age. This scheme has the advantage of giving due prominence to the remarkable but still unexplained cheapening of bronze that distinguishes the Late Bronze Age and its results; for neither this fact nor its implications had previously been given adequate recognition. But I shall show elsewhere that its technological and social repercussions were not of comparable magnitude to those following the development of iron working. Incidentally, the term "Full Metal Age" has already been reserved to designate an earlier technological stage that in some regions—in the Wessex culture, for example—is of considerable significance. Nevertheless, I believe that for the presentation and exhibition of archæological results, a scheme on the lines outlined under (9) by Daniel will prove more fruitful than any rationalization of Thomsen's trinity.

V. GORDON CHILDE.

SOME TRENDS OF AMERICAN THOUGHT

The Early History of Science and Learning in America
Proceedings of the American Philosophical Society, Vol. 87, No. 1. Pp. iii+120. (Philadelphia, 1943.)

Twentieth Century Philosophy
Living Schools of Thought. Edited by Dr. Dagobert D. Runes. Pp. 571. (New York: Philosophical Library, Inc., 1943.) 5 dollars.

Bibliography of Research Studies in Education, 1939–40
(Federal Security Agency, U.S. Office of Education.) (Washington, D.C.: Superintendent of Documents.) 50 cents.

A Challenge to Scholarship
By W. Mansfield Clark. (University of Pennsylvania Bicentennial Conference.) (University of Pennsylvania Press.)

THE first item in the above list recalls the interesting fortunes of the word 'philosophy'—originally the love of wisdom, and the search for causes of all things in heaven and earth. In course of time a distinction was made between natural and moral philosophy, but the old meaning still survives, for example, in the degree of doctor of philosophy. The Royal Society of London, founded in 1660, essentially scientific in its outlook, has ever been famous for its *Philosophical Transactions*, which are records of scientific investigations. The American Philosophical Society was founded at Philadelphia by Benjamin Franklin in 1743. It had little or nothing to do with philosophy as we now understand the term. Its interests lay in new discoveries in what we now call the sciences, in "all philosophic [that is, scientific] experiments that let light into the nature of things, tend to increase the power of man over

matter, and multiply the conveniences and pleasures of life". It was the parent of the American Association for the Advancement of Science, founded in 1840. Since the organization of the latter, the American Philosophical Society has become a local scientific association for Philadelphia. But though a local association, it is broad in its outlook, as its latest *Proceedings* show. Not only does it deal with the part played by the Society in the world of science, and in the development of American education, but also with American contributions to historiography, linguistics, economics, anthropology, archæology and architecture. These *Proceedings* are a most interesting record of a few of America's past achievements in science.

As its title indicates, "Twentieth Century Philosophy" is essentially a book of the day. It is a symposium containing twenty-two chapters, either directly contributed by eminent thinkers and scholars, or otherwise representing their positions. One does not wonder that the editor has found it difficult to bring together under one cover thinkers of such divergent principles and temper, and that, having let each of them state his case, he leaves it to the reader to draw his own conclusions. Among the contributors we note the names of J. H. Tufts, Whitehead, Russell, Dewey and Santayana, and among the chapters of special interest to the man of science we note those on the philosophy of science, logical empiricism, the stories of American realism and pragmatism, philosophic naturalism, and the dialectical materialism emanating from the U.S.S R. The whole forms a useful compendium of living, and warmly contending, schools of thought. If it is the business of each thinking man, whether American or not, to make his own philosophy, his own general outlook upon the universe, this book will help him in his quest, and may help him to understand and tolerate systems which he rejects.

We turn to a topic of wider appeal to readers of this journal—that of the encouragement of research. The liberal provision made for research in the United States is well known in Britain, and indeed Britain has had the advantage of sharing in that liberality. The way they do such things in the United States is exemplified by the extensive bibliography of research studies in education 1939–40, recently issued by the U.S. Office of Education. The book contains 4,012 entries of theses and studies reported by 133 places of education, mostly universities and teachers' colleges, and a few technical institutes. An analysis shows 674 doctors' dissertations, 3,183 masters' theses, and 155 studies reported as faculty research.

In an important sense the figures are revealing. We may assume that the studies reported by faculty members are real contributions to knowledge, and that as a rule, though in a less degree, the same may be said of the doctors' dissertations. There remain the masters' theses, written for the master's degree, and constituting no less than three fourths of the impressive total. Their object is to ensure that a person who has shone sufficiently in his 'recitations' at school, and has attended the appointed lectures at college, shall give evidence of ability to do a piece of independent work. Usually it consists of a few score pages of typescript on a local theme, such as a survey of education in a certain county of the State, or "the effect of the use of separate answer-sheets on reading test results", or "a study of family life in its relation to education in the second grade" of a certain school. There is no question as to the value of these theses for the writers' own education. Only in an elementary sense, however, can they be called contributions to new knowledge. They exemplify a principle now recognized as vital in all progressive schools, both in the United States and in Britain. It is worth recording that in Victorian England the way was led by eminent teachers of science, such as L. C. Miall of Leeds and Lloyd Morgan of Bristol, who emphasized the difference between finding out and being told, and thereby led teachers to realize that pupils from an early age may be led into the paths of simple research.

To return to the question of research in the higher sense. There is no need to emphasize its value, for it is recognized as the life-blood of science. There is, however, a correlative truth which is apt to be lost sight of, and which was forcibly brought out in an address entitled "A Challenge to Scholarship" delivered at the bicentennial conference of the University of Pennsylvania by Dr. Mansfield Clark, professor of physiological chemistry in the Medical School of Johns Hopkins University. He shows how American teachers imported from Europe not only the scientific ideal of research, but along with it the philosophic ideal of an organized system of thought. Undoubtedly, he says, we have added much of our own that is good, but "what needs examination is the tendency in scientific circles to enthuse over research alone". He recalls that in 1896 Merz, in his "History of European Thought in the 19th Century", gave warning of the decay of the ideal of *Wissenschaft*, "a decay that someone put tersely when he remarked that the German scholars had got into the habit of going down deeper, staying down longer, and coming up muddier, than any other". In the United States, says Dr. Clark, the danger that threatens education in the sciences is in "the crumbling of the ideal that a goodly part of scholarship is the studious maintenance of balance between the advancement of knowledge and its consolidation". One realizes his meaning when he adds incidentally that "the last decennial index to *Chemical Abstracts* contains about two million entries !"

In conclusion, it is interesting to observe how the ideal of research has fared in another great country which has temporarily fallen on evil days. At a conference held in May last by the Association of University Professors of Allied Countries in Great Britain ("The Function of a University in a Modern Community." Pp. 57. (Oxford: Basil Blackwell. 1*s*.)), Prof. Paul Vaucher noted among the distinctive features of French universities the importance attached to a high standard of general culture—an ideal which dominated university organization. During the last forty years, however, profound changes have taken place, as the organization "was not well suited to promote scientific research or to provide for students a proper training in research". Hence the development of laboratories in the faculties of science and medicine, and of seminars in the faculty of arts. "Individual scholars, disregarding the critics who often accused them of being under German influence, started creating centres for collective research and for common training in research."

So we are reminded that, whether in the United States or Britain or France or Germany, the scholar and the scientific worker as such are simple seekers after the truth, the whole truth, and nothing but the truth. T. RAYMONT.

SCOPE AND LIMITATIONS OF INFRA-RED MEASUREMENTS IN CHEMISTRY*

By Dr. H. W. THOMPSON
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FOR some years infra-red spectroscopy has been a valuable research tool in pure chemistry, particularly in problems of molecular structure and the deduction of molecular data. Its value in industrial work, both for routine and research measurements, is now becoming fully appreciated, and its usefulness in general organic chemistry may soon at least equal that of ultra-violet spectroscopy. It is therefore opportune to consider its uses and limitations.

The infra-red may be said to extend between wave-lengths of about 1 μ and 10^4 μ. This corresponds to a range of frequencies 3×10^{14} to 3×10^{10} per second, or 10^4 to 1 wave numbers. A small region from the visible up to 1·2 μ can be studied photographically, using conventional spectrographs with glass prisms or finely ruled diffraction gratings. Between 1 μ and 25 μ, prism spectrometers are most often used, in which the prism is made of quartz, fluorite, rock salt or potassium halides. Since large natural crystals of these materials are growing scarce, their production recently in large blocks by cooling the molten salts is important. Diffraction gratings have to be used at wave-lengths beyond 25 μ, although they are also used at shorter wave-lengths if higher resolving power is required. In order to obtain a greater concentration of energy and avoid its dissipation among many spectral orders, these 'echelette' gratings are ruled with specially shaped grooves so that reflexion occurs at favoured angles. The infra-red radiation is usually detected by means of thermo-electric devices. Striking advances have recently been made by the development of very sensitive vacuum thermocouples and voltage amplifiers, thus leading to an increase in both sensitivity and stability of the galvanometric systems, and to the construction of automatically recording spectrometers. In this way, infra-red technique has ceased to be a delicate research method and has become more easily applicable by non-specialists.

Infra-red emission spectra are rarely intense enough for measurement, and we are nearly always concerned with the absorption spectra. In this spectral range, the quanta of energy absorbed cause the molecules to rotate and vibrate. In order to absorb rotational quanta, a molecule must have a permanent dipole moment. Vibrational quanta are absorbed if the particular vibration involves a changing molecular dipole moment. Thus, although homonuclear molecules like hydrogen or nitrogen do not absorb vibrational quanta, methane can do so, since it can perform an unsymmetrical nuclear vibration which produces an electric moment.

Rotational quanta are nearly always small, and the pure rotational spectra therefore lie at very long wave-lengths, between about 10^2 μ and 10^4 μ, or 1–100 wave numbers. Little is so far known about them, mainly owing to technical difficulties in studying this region, but also because of their complexity with all except diatomic molecules. In the latter case, the spacing between rotational lines leads to the molecular moment of inertia and hence to the bond-length.

Vibrational quanta are larger, the fundamentals varying from about 100 cm.$^{-1}$ to 4,000 cm.$^{-1}$. The fundamentals, lower harmonics, and combinations are therefore absorbed between about 100 μ and 1 μ. Changes in rotational energy usually accompany the absorption of vibrational quanta, and with gases or vapours this gives rise to a fine structure of the vibration bands, the precise details of which are of great significance. With liquids and solutions, the intermolecular influences lead to the disappearance of this rotational structure.

A rigid non-linear molecule has $(3n-6)$ normal vibrations, and a linear molecule $(3n-5)$. With simple symmetrical molecules like carbon dioxide, water or ethylene, it is possible to specify in a general way the geometrical form of these vibrations. They can sometimes be described as 'breathing', 'rocking', 'bending' or 'twisting' motions, and it is also sometimes convenient to differentiate between valency vibrations and deformational modes according as the motions of nuclei are along or perpendicular to the valency bonds. If a molecule has some degree of symmetry, its vibrations can also be characterized with reference to each element of symmetry, and by the way in which the electric moment changes with reference to these symmetry axes. Thus, the 'breathing' vibration of carbon dioxide is symmetrical with respect to the centre of symmetry—the carbon atom; and the other stretching vibration is antisymmetrical. In the latter case, the change of electric moment occurs in a direction parallel to the molecular axis, which is an axis of symmetry; in the deformational mode of carbon dioxide, however, the change in moment is perpendicular to the molecular axis. When the molecule has several planes, or other elements of symmetry, a given vibration may be symmetrical or antisymmetrical with respect to each. In the same way the total change in electric moment in different vibrations will vary in magnitude and in direction with respect to the symmetry elements. Some vibrations, for example, the totally symmetrical modes of ethylene, will involve no change in electric moment, and will not be absorbed as fundamentals in the infra-red. In other cases, the intensities of absorption will vary as the position-rate of change of electric moment during the vibration. For these reasons, intensities, taken alone, are no rigid guide in the allocation of observed frequencies to the fundamental modes. Many semi-empirical rules have to be applied, such as the persistence of some magnitudes through a related series of compounds, the fact that motions of lighter nuclei will usually have higher frequencies than those of heavier ones, and the comparison of spectra of isotopic molecules, particularly those containing hydrogen and deuterium.

For certain purposes, a correct assignment of the fundamental frequencies is essential. The Raman spectrum provides valuable additional data. Here, vibrations are active if they involve a changing molecular polarizability. It therefore happens that frequencies which are not found in the infra-red spectrum may appear in the Raman spectrum, and vice versa. Raman frequencies also differ in their degree of polarization, which may enable us to allocate them more precisely to different types of vibration. Some oscillations, such as the twisting mode of ethylene, are inactive in both Raman and infra-red spectrum. These can sometimes be determined from fluorescence data, or from a comparison

* Substance of the Tilden Lecture, delivered before the Chemical Society on January 20.

of the measured specific heat with that calculated statistically using all the known frequencies.

The other important guide in assigning the vibration frequencies is the analysis of the rotational structure of the infra-red absorption bands. If the molecule has some symmetry, this rotational structure differs according to the direction in which the electric moment changes with reference to the axes of symmetry. The differences are often so characteristic that inspection may serve to allocate the vibration to a particular symmetry class. Detailed analysis of the spacings between the rotational lines may simultaneously lead to the moments of inertia and hence to knowledge about the molecular structure, and much information about simple molecules obtained in this way is more accurate than by any other method.

Such rotational analyses are limited, however, to molecules which are (*a*) volatile enough to be studied as vapours, (*b*) small enough to have low moments of inertia and resolvable structure, and (*c*) have some symmetry. These restrictions are severe, and most molecules with which the chemist has to deal are excluded. Even if (*b*) and (*c*) do not apply, however, useful information can often be obtained. Thus, if there is some symmetry but the moments of inertia are large, the envelope of the rotational structure, or band contour, can be measured. This contour, like the rotational structure itself, varies characteristically with the direction in which the electric moment changes during the vibration with reference to the axis of symmetry. By measurement of the spacing between sub-maxima in the band contour, moments of inertia can be roughly determined or an assumed molecular structure confirmed. If the molecule is asymmetrical, the rotational fine structure of bands is very complex, and although this class of molecules includes such simple structures as water, hydrogen sulphide, ethylene, and formaldehyde, few satisfactory analyses have so far been achieved. Here again, some progress can be made by measuring the band contours. These differ according as the direction of change of electric moment is parallel to the least, middle or greatest axis of inertia. In practice, hybrid contours are to be expected, since the change of electric moment will have components along more than one of these axes; but in many cases the contours are surprisingly simple, and not only help in assigning the frequencies but also serve to confirm assumed molecular structures.

It must be emphasized that even when all three principal moments of inertia of a molecule are known, the whole structure often cannot be deduced, since there are more than three bond-lengths and angles. One or more of the latter must then be assumed in order to determine the others. When data are available for a series of related molecules such as the methyl halides, self-consistency in the whole group may be a useful guide. In other cases, comparison of isotopic molecules is valuable, particularly those containing hydrogen and deuterium.

Another serious difficulty in analysing rotational structures and contours results from perturbation of energy-levels due to interaction of vibration with rotation, which tends to be specific. On the other hand, incompletely resolved or partially unexplained rotational structures often serve to decide between alternative molecular configurations. In this way hydrogen peroxide has been shown to be non-planar, and formic acid to have a *cis* rather than *trans* structure.

When molecules are involatile, or large, only the vibration frequencies may be determinable. If all the frequencies are known, the specific heats can be calculated, using the results of statistical mechanics which relate them to the partition function. Discrepancies in some cases between the calculated and measured values have been correlated with the phenomenon of restricted rotation about bonds in organic molecules. Estimation of the potential energy barriers restricting such internal rotation in series of molecules have now been made and throw some light on the nature of the forces between non-bonded atoms in molecules. If in addition to the vibration frequencies, the moments of inertia are also known, the free energy and entropy can be calculated; and provided other thermochemical data are available, so that changes in zero-point energy can be calculated, equilibrium constants can be calculated for reactions where they cannot easily be measured.

If molecules are regarded as a system of mass points between which harmonic forces operate, it is possible to derive equations relating the vibration frequencies with the nuclear masses and force constants for stretching of bonds and bending of angles. Comparison of the force constant of the same linkage in different compounds will give a direct indication of the multiple or hybrid character of bonds. Interesting results have been obtained in this way for some relatively simple molecules. Progress is limited, however, not only by the severity of the computations required, but also by the more fundamental problem of selecting a valid function to express the variation of potential energy with nuclear configuration. Different types of force field have been assumed, and although no general rules can yet be laid down, the most satisfactory seems to be that which assumes in addition to valency forces certain interaction terms. Future progress must be guided by considering series of related molecules, and thus discovering which types of interaction are important.

As explained already, particular vibration frequencies will be permitted to appear either in the Raman spectrum or in the infra-red spectrum, in both, or in neither, according to the symmetry point group to which the molecule belongs. A comparison of the spectra may therefore fix the symmetry class, and hence decide between possible alternative molecular structures. Benzene and cyclohexane have been studied in this way. In the former case, the question is to decide whether the molecule has a centre of symmetry, which a resonance hybrid should show, but which the Kekulé structure does not have. In the latter case we have to decide between a planar, boat-shaped, or chair-shaped structure. Results are so far rather unconvincing, mainly because the Raman measurements are normally made with the liquids, where molecular distortions lead to a break-down of the selection rules.

Although any molecular vibration in reality involves the whole molecule, some linkages retain individuality and give rise to characteristic absorption frequencies. Such linkages can therefore be detected or estimated in molecules. The absence of the characteristic O–H group absorption in some hydroxy compounds has proved the existence of the hydrogen bond and revealed unexpected cases of inter- and intra-molecular association. The individuality of linkages tends to disappear when the nuclei are roughly equal in mass or the force constants roughly equal in value. In spite of this, some nuclear skeletons,

such as the nitro or tertiary butyl groups, retain characteristic sets of frequencies in different compounds. Deformational motions are also sometimes characteristic. For example, the symmetrical deformational frequency of the CH_3-group can be used to indicate its presence in polythene; and different types of olefine can be distinguished by differences in some of their deformational vibrations. The latter results can be used to study the cracking of hydrocarbons or the method of polymerization of unsaturated compounds. Thus, when 1.3 butadiene condenses to form buna rubber, the extent of 1.2 or 1.4 addition can be estimated. In polymeric chemistry a variety of problems can be tackled successfully, such as the arrangements within a long chain, or the structure of interpolymers.

Since no two molecules, except a pair of optical isomers, have the same nuclear configuration, the fact that any molecular vibration involves the entire molecule implies that no two molecules will have a completely identical set of vibration frequencies. The infra-red spectrum will therefore be a fingerprint of the molecule. On this basis, many mixtures, sometimes of great complexity and not susceptible to other methods, can be analysed. The method is particularly suitable for isomeric mixtures. Even stereoisomers show different spectra. Analyses of this kind are rapid and require a very small amount of material. Certain technical difficulties still exist, but are rapidly being overcome, and the method has wide applicability in organic chemistry. Accurate measurements on absorption intensities may also lead to more detailed knowledge about the nature of chemical bonds.

THE ANTIQUITY OF MAN IN AUSTRALIA

By PROF. F. WOOD JONES, F.R.S.
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A LARGE part of a recent Memoir of the National Museum, Melbourne (No. 13, 1943), is devoted to the question of the authentic antiquity of certain human artefacts and skeletal remains that have been recorded from various parts of Australia over a long series of years. The available evidence in relation to each find is carefully analysed, and a judicial summing up leads, in most cases, to a verdict of 'not proven'.

This new survey has been undertaken by the director of the Museum, Mr. D. J. Mahony, as a consequence of the recent discovery of mineralized human remains near Keilor at the junction of Dry Creek and the Maribyrnong River in the neighbourhood of Melbourne. The skull was unearthed from undisturbed strata 18 ft. below the surface. The district in which the find was made shows the presence of three distinct river terraces. The terrace from which the skull was excavated is the highest of the series and is 45 ft. above the adjacent river bed, the other terraces being respectively at the 36-ft. and 27-ft. levels. Mahony's conclusion from a geological survey of the area is that the terraces "represent the eustatic rise of sea level during the Riss-Würm interglacial phase" and that "the skull and the terrace are evidently contemporaneous". The correlation of the European Riss-Würm period with happenings in southern Australia and Tasmania is made in the assurance that "most glaciologists consider that glacial and interglacial phases were contemporaneous in both hemispheres".

The circumstances of the finding of the skull *in situ* in the undisturbed face of a sand-pit seem to be well authenticated. The skull itself is mineralized and bears every evidence of being contemporary with the stratum from which it was removed. We may therefore claim that the Keilor skull is the first Australian human fragment the geological antiquity of which is definitely guaranteed by the circumstances of its finding and that, in the opinion of competent Australian geologists, it dates from the Riss-Würm interglacial phase of the Pleistocene period. We may consider its geological story as settled, subject only to possible minor differences of opinion among experts concerning the precise age of the deposit in which the skull was found.

The study of the human remains is, however, far from being completed. In the introductory paper by Mr. Mahony, it is said that "Two mineralised human skulls and some other bones were found". The actual finder of the skull mentioned "one fossilised limb bone and several other fragments" as being with the skull. He adds that "since then five pieces of another skull were found at the same level and about 6 feet distant from the first skull". Only one skull (lacking the mandible) is in the possession of the National Museum, and it is the only specimen dealt with in this publication.

The account of the skull is written by Dr. J. Wunderly and that of the palate and maxillary teeth by Dr. W. Adam. Neither of these accounts can be considered as being definitive descriptions of the characters of the skeletal remains, and it might have been well to limit the account of the skull to a simple statement of its characters and to have refrained from any suggestions as to racial affinities until the rest of the skeletal remains were available for examination. Dr. Wunderly's conclusions concerning the skull are that "it combines Australoid and Tasmanoid characteristics in about equal proportions". Further, he states that "the Australoid and Tasmanoid anatomical characters are consistent with the theory that the Australians had a bi-racial origin, and also with the supplementary theory that Australia was originally peopled by Negritos. The presence of characteristics of the two racial types is more important than their proportional relationship". I find it difficult to understand the meaning of this last statement. Presumably it means that the Australian race as we know it is compounded of two primary races. But if Dr. Wunderly means that these two primary races were what we now know as Australians (Dravidian or Pre-Dravidian Cymotrichi) and Tasmanians (Oceanic Ulotrichi) is not clear, for the peopling of Australia by Negritos (presumably Tasmanians) he relegates to a "supplementary theory". Should he, in fact, mean that the Australian race is compounded of a Pleistocene Australian-Tasmanian mixture, he must be prepared to admit that the Tasmanian race is equally a mixture of the same two elements. For if that is not admitted, explanation is needed as to how, when Australian and Negrito (Tasmanian) had formed a mixed race in continental Australia in Pleistocene times, the Tasmanians, with all their racial characters intact, were present in Tasmania on the arrival of the white man. Only two possible explanations seem to present themselves. The first is that it so happened that the Ulotrichous Negritos who passed from Australia to Tasmania chanced, in

some extraordinary way, to have avoided this racial admixture with Australians during their occupation of Australia. The second, that the influx of Negritos into Australia was an event altogether separate from their advent into Tasmania: that there were two independent Negrito migrations, one into the mainland that merged its blood with that of the Australians, the other into Tasmania direct and not via continental Australia and so preserving their full Negrito characters. It cannot be claimed that either of these hypotheses tends to clarify the question of the peopling of the Southern Continent.

Concerning the palate, Dr. Adam concludes that "it is more Tasmanoid than Australoid" in certain features. One of these features is that "it is relatively broad like the Tasmanian palate; the Australian palate is relatively narrower". It is unfortunate that of the Tasmanian and Australian palates figured in Plate XI, that of the Australian would seem to be of a considerably higher relative broadness.

The question would seem to arise as to the possibility of any physical anthropologist sorting out the constituent racial elements present in any individual skull. Tables of figures of comparative measurements are impressive; but it would seem that they are incapable of solving the problem. Taking Dr. Wunderly's tables 1 and 2, in which he gives measurements for Australian, Tasmanian, Maori, Marquesan and Hawaiian skulls, it is at once apparent that it cannot be from these that he has drawn the conclusion that the Keilor skull is compounded of Australoid and Tasmanoid characteristics in about equal proportions. If the measurements of the Keilor skull are matched with the measurements given in the tables of the other skulls, it will be found that in fifty-seven instances they come nearest to those of Australians, in thirty to those of Maoris, in twenty-nine to those of Marquesans, in twenty-one to those of Tasmanians and in eighteen to those of Hawaiians. Surely this is a very disconcerting result to be achieved by the refinements of craniometry. On the other hand, it can scarcely have been on the anatomical features of the skull that Dr. Wunderly makes such a very definite statement, for the morphological characters referred to in the communication are quite insufficient for arriving at a dogmatic diagnosis of racial mixture between the Pleistocene ancestors of the present Australian and Tasmanian races. It might be considered among the triumphs of craniology to diagnose with certainty the product of racial mixture between the Australian and the Tasmanian of the historic period. It is a bold claim indeed to be able to recognize an isolated cranium of an individual as being the product of the racial mixture between the Pleistocene ancestors of these two races living (according to the geological report) more than 100,000 years ago.

It is probably the assertions of Wunderly and Adam that have led Mr. Mahony to include the sentence, "The Keilor skull, which combines Tasmanian with Australian characteristics, supports the theory that Tasmanians once occupied the Australian mainland", in his admirable survey of the whole question of the antiquity of man in Australia. From Australia it is postulated that the Tasmanians passed by way of the Bass Straits Islands into Tasmania. Perhaps, therefore, it would be well to point out that, altogether apart from the question of race mixture already mentioned, there are several other difficulties in the way of accepting this hypothesis. If Tasmanians and Australians had inhabited continental Australia side by side and had fused their races in Pleistocene times, it must be explained how it came about that the Tasmanian when first encountered by the white man had no dog, although the Australian had, even at the dawn of his story, dogs in plenty, for fossil dingo bones occur in Australia. No remains of the dingo, living or fossil, have ever been found in Tasmania or in the Bass Straits Islands; yet it is a historic fact that the Tasmanians eagerly seized on the cur dogs of the white man to assist them in their food quest. How came it that the Tasmanians remained ignorant of such familiar and important cultural developments as the use of the throwing stick, the stone-pointed spear, the boomerang and the shield, familiar enough and of widespread use in Australia ?

The National Museum and its director are to be congratulated on having placed on record the first really well-authenticated example of human remains, assignable to a definite geological horizon, that has so far been brought to light in Australia. Here we have a genuine human document of first-class importance. The skull is safe in the custody of the National Museum, and it is much to be hoped that all the other human fragments will be placed in its permanent collections. There will be many opportunities for further examinations of the skeletal remains by anthropologists, and meanwhile it would perhaps be better to accept them as permanent documents rather than to assume that the conclusions drawn from their first examination are necessarily the final ones.

COMPETITIVE RUBBER PLANTS*

By G. MARTIN

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FAR more plants contain rubber than is generally realized, but few contain enough to make extraction worth while. For example, the dandelion (*Taraxacum officinale*) is typical of the plants in Great Britain which, on bruising, yield a latex or milky fluid containing rubber; but the milk contains much more resin than rubber, and the latter only amounts to about 0·2 per cent of the plant.

The Russian dandelion, kok-saghyz, is similar in general appearance to English dandelions, but contains a much higher proportion of rubber, usually about 10 per cent. Experiments on the cultivation of kok-saghyz are being made in Great Britain, under the general direction of the Royal Botanic Gardens, Kew, as well as in other parts of the Empire and the United States, but it will be difficult, for the time being, to spare in Great Britain the tens of thousands of acres of good agricultural land which would be required to produce 1,000 tons of rubber a year, which is only 1 per cent of our imports prior to 1939.

The rubber-bearing plants of Great Britain are few and insignificant compared with those in other parts of the Empire. According to a report of the Imperial Agricultural Research Institute of India, there are in that country 268 species of plants which are stated to contain rubber. A list of rubber-bearing trees, bushes and plants in Africa, recently prepared by

* Substance of a paper read before the Royal Society of Arts on December 14.

the Imperial Institute, contained the names of 137 different species. Rubber-bearing plants also occur in Northern Australia, Ceylon and the West Indies. Although it would appear that the Empire is rich in rubber-yielding plants, most of them yield a complex mixture of vegetable substances of which rubber forms only a small percentage. No product containing less than 10 per cent is likely to be of value as a source of rubber, and even this proportion raises difficulties. This is unfortunate, as several plants yield copious supplies of latex, the solid content of which contains between 10 and 20 per cent rubber hydrocarbon. Probably the best known of these plants is the bush *Euphorbia tirucalli* and other species of Euphorbia in South Africa. One tapper can collect about two gallons of Euphorbia latex a day, which is equivalent to about 6 lb. of solids containing, at the most, 1 lb. of rubber. The most expensive item in the operating costs of rubber production is tapping and collection, and more than ten times the labour force is required to produce the same weight of rubber hydrocarbon from Euphorbia sp. as from plantations in the East. In addition, the rubber hydrocarbon of Euphorbia is mixed with six or seven times its weight of vegetable resins which make it soft and difficult to vulcanize without purification. The usual method of purification is to extract the resins with a solvent, such as alcohol. The purified rubber is of fair quality, and can be used in association with better rubber for many purposes. The mechanical difficulties of purification are, however, considerable and have not yet been overcome on a large scale.

In view of these difficulties it is probably easier and more economical in man-power and materials to find uses for the unpurified product in directions where the strength and elasticity of rubber are only required to a mild extent. This is the policy which has been pursued in Great Britain in connexion with the utilization of Niger paste, which is the coagulated latex of *Carpodinus hirsuta*, a vine widely distributed in West Africa. The paste contains little over 10 per cent rubber hydrocarbon, but intensive investigations by a number of organizations have indicated directions in which it can be used without purification, and which will save a corresponding proportion of good rubber for important purposes.

The rubber-bearing plants of importance in the present emergency yield products containing at least 75 per cent hydrocarbon, and some of them between 85 and 90 per cent, which is almost as pure as rubber produced on the Eastern plantations. Reference should be made, however, to a tree, *Ficus vogelii*, widely distributed in the forests of West Africa, which yields a product containing 50 per cent rubber hydrocarbon. Single trees furnish as much as 10 lb. of solids annually. The product is too impure for the more exacting uses of rubber, and, prior to the present emergency, there was no market for it. It can be used, however, in manufactures where a high proportion of rubber is not required.

The source which dominates all others is, of course, *Hevea brasiliensis*, which is a large tree about 60 ft. high, generally grown from seed, and is not ready for tapping until five years after planting. The trees are planted about 100 to the acre, and each mature tree yields about 5 lb. of rubber per annum. Some trees yield much more than this, and by grafting the buds of large yielders on to a suitable stock, it has been possible to develop progeny which yield more than 1,000 lb. per acre. The trees are tapped by removing a shaving of bark from a portion of the circumference. Immediately the cut is made, rubber milk or latex commences to exude and slowly flows over the cut surface into a cup attached to the tree. Each tapping yields about 3 oz. or more of latex, containing about 1 oz. of rubber. One tapper can tap about 300 trees per day, and so obtains about 15 lb. of rubber. The latex is transported to the estate factory, where the rubber is separated by adding an acid. The coagulum is then passed through mangles and finally dried either in air or in smoke.

The outstanding advantages of Hevea as a source of rubber are the large yield per acre, the low cost of collection, the low maintenance costs and the ease with which rubber of the best quality is separated from the latex. On the other hand, Hevea takes many years to reach maturity, and each individual tree then requires the attention of a tapper at intervals of a few days, and it is only because yields are high and labour is cheap that rubber can be produced at about 6*d*. per lb. After the latex has arrived at the factory and can then be handled on a large scale, the cost of manufacture is extremely small.

In the case of a small plant, such as kok-saghyz, it is possible to envisage a cheap annual crop based on mechanical cultivators, harvesters and mass-production factories. The retail price of beet sugar suggests that dandelion farms, supplying central factories, may be able to produce rubber at 6*d*. per lb. so long as yields are good and the technical side runs smoothly. Yields are not yet good enough in a strictly competitive market, and factory treatment requires further study.

The difficulties involved are illustrated by the fact that guayule, a product of the bush *Parthenium argentatum* which can be grown and treated like kok-saghyz, has struggled along for twenty years, receiving intense scientific and practical study in California and is still unable to compete with Hevea. Guayule rubber is, however, a much more resinous product than kok-saghyz and the bush is rather difficult to cultivate, so that the slow progress of guayule is not a satisfactory guide to the rate at which developments may be expected in kok-saghyz.

A considerable amount of attention is now being devoted to a woody climber, known as *Cryptostegia grandiflora*, which is a native of Madagascar, but grows like a weed in northern Australia, in various parts of India, in Florida and the West Indies. The Americans think so highly of this plant that they have recently arranged to plant 100,000 acres in Haiti. A large area has also been planted in India, and experiments are in progress in Australia. The chief advantage of this plant is that it grows about 6 ft. in the first year, forming a stem about 1 in. in diameter, which is then ready for tapping. It can be planted 10,000 to the acre, is not exacting with regard to climate or soil, continues to thrive when cut and produces an abundance of seeds which are very fertile. The rubber is not quite as good as that from Hevea, but contains about 75 per cent hydrocarbon and can be used satisfactorily for practically all purposes. The method of tapping most favoured at the moment is to tie together the ends of, say, 12 shoots, cut off about 1 in., and then immerse them in a small container. A few drops of latex fall from each shoot and there remains behind a small button of rubber on the cut surface, which is subsequently removed. Estimates of yield per acre vary between

200 and 750 lb. per annum, but estimates have a habit of not being reached in practice, and experience at present is very limited.

Other sources of rubber were intensively developed thirty years ago and have only faded into the background because of the economic predominance of Hevea. Some of them are large trees like Hevea, some are vines and others are shrubs. They all yield reasonable amounts of good-quality rubber and are being exploited to-day in so far as labour is available.

The most important of the trees is *Funtumia elastica*, which is widely distributed in the forests of west and east tropical Africa. Under forest conditions, it is a large tree with a straight trunk and smooth bark and does not branch until it reaches a considerable height. The usual method of tapping is to remove a small vertical channel of bark, the tapper, by means of ladders and slings, climbing to a height sometimes of 60 ft. As he descends he makes inclined incisions, joining the main channel, and so forming a herring-bone pattern on the tree. The latex exudes and flows along each of these side-channels and down the main channel into a small receptacle attached to the tree near its base.

When Hevea is tapped, the cut surface remains vital, and, on removing a fresh shaving a few days later, the latex again flows and the irritation of continuous tapping causes the flow of latex to increase. This is known as wound response. In the case of Funtumia, the lower edge of the cut dries up and suffers from die-back, so that in order to obtain more latex it is necessary to remove a very thick shaving of bark or to tap in an entirely different position. This eventually results in the death of the tree. Ingenious methods have been devised to overcome this difficulty, but they do not appear to be universally successful. Whatever method is employed, the first tapping yields the most latex, after which the yields rapidly decrease, even when an interval of several months elapses between each tapping. The amount of rubber obtained at the first tapping is usually about 4 oz., so that in order to obtain 10 lb. of rubber, which is the minimum daily output of a tapper in Malaya, it is necessary for one man to tap forty Funtumia trees. In view of the height to which these trees are tapped, and the fact that one acre of forest may contain only two or three trees, it is impossible for wild Funtumia rubber to compete with plantation Hevea.

In the early days of the rubber-growing industry, it was urged that since Funtumia trees were so widespread in Africa, it was the ideal tree to grow on plantations in that country. The argument had considerable appeal; but tapping difficulties and the poor yield, with consequently higher costs of collection, were fatal, and most of the plantations were eventually abandoned. Those which have not been destroyed are proving of value in the present emergency, but so far the problem of economic production remains unsolved, and there is no indication that after the War the exploitation of these trees will be continued. The rubber is of excellent quality, but not quite so good as Hevea rubber.

Another tree which attracted much attention in the early days is *Manihot glaziovii*, more popularly known as ceara. It is a smaller tree than Hevea and can be planted more densely. Whereas Hevea plantations usually have 100 trees or less per acre, ceara plantations have about 300. The tree is also less exacting with regard to climate and soil. This suggested to the early planters that the ceara tree might be grown in localities where the conditions were not favourable to Hevea, particularly in parts of Ceylon and in East Africa. The tree grows very quickly from seed, and can be tapped after two years. This is of great interest in the present emergency, in which the development of quick sources of rubber is of strategic importance. It is only fair to point out, however, that no authoritative information is available about the yields of young ceara or about the quality of the rubber. The tapping of young trees with thin bark, small surface and poor yields presents considerable difficulty and has not been studied as a commercial proposition.

Even the mature ceara tree is not easy to tap, and the yields are so low in the dry areas that insufficient latex exudes to overflow into a receptacle. A higher yield is obtained in the more humid areas, but an annual yield of 200 lb. per acre, containing 300 trees, is above the average and compares unfavourably with Hevea. Very high yields are recorded for individual ceara trees—as much as 10 lb. per annum. This corresponds to 3,000 lb. per acre, if it is possible to develop reliable, high-yielding offspring, but the low yield is not the only factor operating against future development. The ceara tree does not stand up well to tapping, particularly in the dry areas. So late as 1914 it was reported from Ceylon that no method of tapping the tree was known which did not cause death. In addition, the bark of the ceara tree has a hard outside layer, which quickly blunts the tapping knives, and which also tends to separate from the inside layer which contains the rubber-bearing vessels. It is usual, therefore, first to remove the outside layer from the area which has to be tapped, and then to employ a conservative system of tapping so as not to injure the tree.

There are a number of abandoned ceara plantations, particularly in East Africa, which have now been reopened, but prospects after the War do not appear promising.

The most important indigenous sources of rubber in Africa are the numerous woody large vines, widely distributed in the tropical forests. The principal genera are Landolphia, Clitandra and Carpodinus, containing numerous species. The best sources of rubber are confined to four or five species of Landolphia in West Africa and a similar number in East Africa, together with a little Clitandra and Carpodinus. The vine rubber from these sources is of excellent quality, that from the Landolphia spp. containing about 90 per cent hydrocarbon in West Africa and 85 per cent in East Africa.

In the rubber boom of 1910, when the total output from all sources in Africa reached 20,000 tons, vines were recklessly tapped and, in many cases, completely destroyed. A vine requires about ten years to grow from seed and about five years to grow again when partially cut down, so that the damage done during the rubber boom is by now largely repaired; but the balancing of productive capacity against probable useful life is still important, particularly as there is a risk of obtaining much rubber at first and none during the rest of the war period.

A usual method of tapping is to cut the bark at intervals, and climbing among its twisted branches for the purpose is regarded as hard and dangerous work. The yield is 1–8 oz. of rubber per vine, and

after several months, when the cuts have healed, the treatment can be repeated. An area of forest containing two vines per acre is regarded as a rich source of rubber, so that 1 lb. of rubber per acre is an excellent yield. A cautious tapping treatment would probably have little effect on the life of the vine; but the tendency is to get as much rubber as possible with the least effort, so that it will not be surprising if the yield of vine rubber reaches a peak and then diminishes as the sources of supply are destroyed.

In normal circumstances vine rubber cannot hope to compete with plantation rubber produced in the Far East, chiefly because the harvesting of the rubber involves the same type of operations with much smaller yields and more difficult conditions. This comment does not apply, however, to some species of Landolphia, etc., particularly *Landolphia thollonii*, which, growing in poor soil in open country, does not develop into a climbing plant, but throws out long underground stems ramifying in all directions, with small tufts of foliage above ground at irregular intervals. The bark of these stems contains about 15 per cent rubber and in some areas, particularly in French Equatorial Africa, there is such a mat of stems that every footstep covers a treasure of buried rubber. The stems have been known to reach sixty yards in length, and as they are only a few inches below the surface they are not difficult to gather and cut off near the tap root. They are then dried a little to coagulate the latex, cut into convenient lengths and smashed with a mallet so as to facilitate the removal of bark. Finally comes the laborious operation of pounding the bark, so as to convert it into a powder and mass the rubber together into small lumps. It is estimated that 15 hours beating is required to produce 1 lb. of rubber. Since the supply of labour is limited, such a process cries out for mechanization. One method is to run the bark for some time through heavy grooved mangles, that is, ordinary rubber washing machines; but these machines are difficult to obtain under present conditions, and there is only a small output for a given input. A study of the problem in Great Britain and in South Africa suggests that the most suitable type of grinding machine is a rod mill, consisting of a revolving cylinder containing loose rods which rise and fall and rotate as the cylinder revolves. The mechanical method is essential to the success of several of the new sources of rubber, such as the Russian dandelion, root rubber, the bark of vine rubber from which the latex does not flow freely and even for bark shavings obtained on plantations in Ceylon, which were often thrown away because they contained only 5 per cent rubber. On a large scale it should be a fairly cheap method of obtaining rubber, particularly if a continuous process can be devised.

A survey of competitive rubber plants would not be complete without a reference to Castilloa and *Ficus elastica*. Both have been cultivated on a small scale in different parts of the Empire, but on account of small yields, and for other reasons, cannot hope to compete with Hevea after the War. The whole trend of this paper shows that trees which have to go through the same cycle of operations as Hevea in order to obtain rubber are hopelessly outclassed by the latter with regard to yield, quality and ease of treatment. Small plants may be more successful, however, because their cultivation and treatment can be mechanized, and operations can be based on an annual instead of a daily cycle.

OBITUARIES

Prof. W. W. C. Topley, F.R.S.

WILLIAM WHITEMAN CARLTON TOPLEY was born in 1887. He was educated at the City of London School, St. John's College, Cambridge, where he obtained a first class in the Natural Sciences Tripos, and St. Thomas's Hospital, London, and qualified in medicine in 1909. In 1910 he was appointed director of the Pathological Department at Charing Cross Hospital, and started a private practice in Harley Street.

In 1914 he accompanied Colonel Hunter to Serbia, where an epidemic of typhus was raging. There is little doubt that his sensitive nature was stirred by the tragedies he saw in a community affected by infectious disease, and that this experience decided his main line of research, namely, an experimental study of the factors involved in the spread of epidemic disease. He returned to England in 1916 and rearranged his life so that he could devote himself entirely to research and teaching. He quickly set to work and showed from the very outset how hard and fast he could work, a characteristic which has staggered all those who have followed his activities.

In 1919 Topley's researches were attracting much attention, and he made a preliminary report of them in the Goulstonian Lectures. In 1922 he accepted the chair of bacteriology at Manchester, and for five years rigidly limited his interests; with a small group working devotedly around him he studied the spread of epidemic disease in mice.

In 1927 he became professor of bacteriology and epidemiology at the London School of Hygiene. Here, in association with Greenwood and other colleagues, he carried on his researches, the results of which and the views which emanated from them he wrote up in his clear, forceful and interesting style. He delivered the Milroy and Harben Lectures, and in 1930 the importance of his work was recognized by his election to the Royal Society. In addition, he threw great energy into the academic diploma course of bacteriology which he had started, and wrote with G. S. Wilson a large text-book of bacteriology. He began, moreover, to take an interest in committee work, and allowed his scientific interests to develop more widely by seeking contacts with scientific men working in other branches of biological research.

In a very short time Topley was serving on the Council of the Royal College of Physicians, the Council of the Royal Society, the Medical Research Council, and the Animal Diseases Committee of the Agricultural Research Council. His book had been an outstanding success; and scientific workers from every side were asking for his time, help and advice. He responded to these added burdens by increasing the tempo of his work and thought, by working harder, and by arranging and rearranging his mode of life so as to attain maximum efficiency.

In 1939, certain that war was coming, Topley was determined to prevent, if possible, the tragedy of infectious disease spreading through the community. Largely due to his efforts, the Emergency Public Health Laboratory Service was set up in Great Britain to combat this danger. At the same time he gave his help to a group of pathologists who, as a result of the experiences of air-raiding in the Spanish War, were pressing for an effective blood transfusion service for the London area, and the London Emergency Blood Supply Depots came into being. As

the Medical Research Council was administering both these services on behalf of the Ministry of Health, he worked during 1939–41 at the Council's head office, developing both services and engaging himself in a host of other war problems with which the Council was concerned. In addition, he was available to all and every scientific worker who, in the stress of war, questioned whether his services were properly employed, or required moral support for carrying on. Even in the midst of all this work, he gave the Croonian Lecture before the Royal Society in 1941, entitled "The Biology of Epidemics". Those who heard him may have felt that this was the swan song of his research experience, but none thought that it was the last time they would hear him, in public, develop a story in his clear, logical and arresting manner.

In 1941 the Agricultural Research Council asked Topley to become its secretary. Few would have considered such a change or such an exacting post unless prepared to sever their old scientific life completely, but Topley could never view it in this light. He believed that if he but drove himself harder, he could master his new duties and keep his old interests and friendships alive. How well he mastered his new work in the two years allotted to him it is not yet possible to judge, but it is clear that revolutionary changes in veterinary research were impending. How anxious he was not to lose his old interests is shown by the very active interest he took in the part that he considered the University of Cambridge should play in the medical, veterinary and bacteriological sciences.

As a man in science, Topley was outstanding. The mainspring of all his activity was devotion to science. Disregarding, save for a caustic remark, those whose scientific integrity was in doubt, he gave without stint his sympathy, understanding and help to all other workers. No matter what it cost him, nothing was too much trouble if his help would increase a worker's efficiency and devotion. He was probably happiest when the young men of science sought his aid, for he knew that the future of science was in their hands and that the young were slightly scared of him. He did not understand why, and nor did they, when after a short time they always spoke of him as "Bill". A talk with him was not easily forgotten, for the ideas bubbled out of his bold and original mind, and he left a sense of exhilaration and enthusiasm which lessened difficulties and made the goal so much more worth the effort. He had that rare quality of brain which, though severely critical, was essentially constructive. He stimulated the hesitant, and spurred on the keen. His honesty of purpose and loyalty continually drew new friends to him, and he excelled in bringing groups of workers together. Frequently responsible for the inception and planning of a research, and for the guidance of the worker throughout, his generous nature allowed no recognition of the fact in the published work.

No one would have used so profitably (or enjoyed more) the period of reconstruction after the War, to further his wide scientific interests and the welfare of scientific workers and their technical assistants. This has been denied him, but his influence lives in so many that much that he desired must come to pass.

As a man, Topley was at times delightfully simple, and at others curiously complex. He had a strong sense of loyalty; nothing gave him more pleasure than his election to an honorary fellowship of his old College, and no man was more staunch to his friends. Yet he feared such loyalties lest they should hinder his service to science. He enjoyed recognition and praise for his election to the Royal Society, and the award of the Royal Medal of the Royal Society delighted him, yet he shunned these delights lest an undue taste for them should chance to warp his judgment. Severely critical as he was of others, he was much more critical of himself. No one was less in need of self-criticism, but this may have been responsible for the curious complexity which he sometimes exhibited.

Those of us who visited him in his home believe we hold the happiest memories. Topley was still the wise man of science, arguing and discussing; but he allowed more latitude to his exuberance, to his puckishness of mind, and he fitted so well into the delightful home background which his wife so unselfishly created for him.

Topley died suddenly at work in his office chair on January 21. Thus passed away, in a manner which he himself would have chosen, an outstanding man of his generation. A. N. DRURY.

Sir Aurel Stein, K.C.I.E., F.B.A.

SELDOM can there have been an instance of a task pursued so constantly, so indefatigably and with such zest through so long a life as by Sir Aurel Stein, who died on October 26, aged eighty. Oriental research, he acknowledged, had claimed him from his student days. More than that, the campaigns of Alexander the Great had fascinated him from first to last, so that he found a special satisfaction in following in his tracks, and, in some of his latest writings published since the beginning of the War in the *Geographical Journal*, turned again to the unravelling of his campaigns.

This pursuit of Oriental research and this fascination felt for the most dramatic incident in the intercourse of East with West, personal though they were, corresponded to a general urge in a period which has probably reached its close, so that, while from one point of view it is possible to regard his career as the fruit of his early self-preparation by work in the study and of persistent concentration on his aims, from another it was one of the main fruits of the impetus given to archæological studies by the viceroyalty of Lord Curzon and the reform of the Archæological Survey of India under Sir John Marshall. Though Stein was born in Budapest and educated in Vienna and Germany before first coming to England, his field-work was made possible by the Government of India.

It was under the Punjab Education Department that Stein first entered Indian Government Service, and while at Lahore he gave his spare time to the translation from the Sanskrit of Kalhana's "Chronicle of Kashmir" (Rājatār angīnī). Meanwhile, the vast regions of Central Asia were attracting explorers from many lands. The journey that claimed most attention at the time was that of the Swede, Sven Hedin, during the years 1893–97. This was undertaken mainly as geographical exploration, but he also carried out some archæological investigations in eastern Turkestan and on the Keriya River east of Khotan. It was, however, the linguistic interest of some birch-bark manuscripts brought back from Khotan in 1893 by Dutreuil de Rhins, to which Bühler directed Stein's attention, that led Stein in 1897 to plan his first journey to Central Asia. He found that antiquities were being brought in to Sir

George Macartney, then Consul-General at Kashgar, for transmission to Calcutta at the instance of Hoernle, who greatly encouraged Stein in his design of investigating their source. It was therefore from the first an archæological rather than a geographical exploration on which Stein started. His first expedition to Central Asia was delayed until 1900, when he set out via Gilgit and Kashgar for a year in the region of the Taklamakan Desert.

It is impossible even to sketch here the course or routes of Stein's three Central Asian journeys. They have been fully reported from several points of view by Stein himself, in narrative volumes, in full-length reports and also in two excellent and compendious sketches, a paper given before the Royal Geographical Society with the title "Innermost Asia: its Geography as a Factor in History", and published in the *Geographical Journal* of May and June 1925, and the section on his own archæological work in Central Asia which he contributed to an account of the work of the Archæological Survey of India published by the India Society in 1939 under the title "Revealing India's Past". Here we can only attempt a general estimate of his method and its fruits. His research was historical and directed especially to the solution of one historical problem—the elucidation of the relations between China and the West, the capacity of the trade routes, the nature of the cultural influences passing along them, the periods which saw these routes most used and the causes which led to the abandonment of them and of the settlements along their course. A striking fact is that whereas he started out with the idea above all of tracing the eastward expansion of the cultural influences of the Hellenistic West, and of India, he came more and more to be impressed by the purpose, organizing power and tenacity of the Chinese who opened these routes and so long maintained them. Hellenistic influence was found to end in the early years of the fourth century A.D., but Indian influence was long continued by the passage of Chinese pilgrims to the Buddhist shrines in India. For the early period his most important discovery was of the elaborate organization of a Chinese *limes* in the Han period, protecting the route through the Tunhuang Oasis and beyond from the incursions of the nomads of the steppe to the north; and of the route, across the bed of the dried-up inland Sea of Lop, connecting this region with Kucha without passing through the relatively exposed Turfan region.

For the history of art Stein's most important finds were the textiles of the Astāna cemetery and the cache of paintings and manuscripts in the walled-up chamber at the Caves of the Thousand Buddhas, near Tun-huang. These with the wall paintings, transported from the sites of Bazaklik, Murtuk, Miran and elsewhere to the new Central Asian Antiquities Museum at New Delhi, have added so much to the material for the study of Buddhist painting in China in the T'ang period as to revolutionize it. Unfortunately, the wall paintings, though listed by Dr. Andrews in his Catalogue of 1933, have not yet been published, and are therefore not yet fully available to students. The Tun-huang paintings, on the other hand, have been fully catalogued by Mr. Arthur Waley, and the whole series was mounted at the British Museum and a great part exhibited there in 1914 on the occasion of the opening of the King Edward Building. The collection was afterwards divided between the British Museum and the Government of India for the Museum at New Delhi, but in 1921 the two Museums brought out jointly a portfolio of reproductions in colour of selected examples from both collections, with an introduction by Laurence Binyon and descriptions by Stein himself. Their importance has therefore been fully realized, though much work remains to be done on them from the stylistic and iconographical sides.

Stein went no more to Central Asia, except for a brief and abortive journey. But, though prevented from following up one line of research, he started on the archæological survey of another great region. He had already traversed Sistan on his return from the third Central Asian expedition, and he now began a series of journeys which eventually covered the whole of that great bridge between the civilizations of East and West which leads from Mesopotamia, over the Iranian plateau, through Afghanistan, and so down into the Indus Valley; or across the Oxus into Turkestan. During all this period of more than twenty years he had two bases, his camp in the Kashmir highlands, and Corpus Christi College at Oxford, where the late president, Dr. P. S. Allen, the Erasmus scholar, always welcomed his friend on his visits to England. Of these journeys, the most important were the tours of the chalcolithic sites of Baluchistan in 1926–27 and 1927–28, and, since 1930, in south-western Persia. His accounts of the first were published by the Archæological Survey of India in its series of Memoirs; the later journies undertaken after his retirement from its service were chronicled in two large volumes. He also made expeditions to the Upper Indus region and followed the Roman frontier *limes* in Mesopotamia.

In all this wide area, Stein followed the course of ancient trade routes with his trained eye and indefatigable zeal. His pertinacity and complete absence of fear carried him over the wildest and most forbidding country. Indeed he was most truly himself when, with his surveying staff and train of porters alone, he viewed from some almost inaccessible spot ancient tracks and, as it were, a whole panorama of past history. Where written texts could illumine the records which he found on the ground, all the evidence which he found fell into a pattern. But in a region of such a long and complex history as he was now exploring, it was not to be expected that Stein should have been able to reach conclusions as definitive as in Central Asia. His explorations have mapped the sites which need to be studied: they call for the methods of the trained excavator and much comparative study before they can yield all their evidence.

Aurel Stein loved solitude. He was happy in a study, but happier in the wide open spaces. When he appeared in the lecture room, as he did in the United States at the Fogg Museum and elsewhere, and in London especially in the Royal Geographical Society's rooms, it was the nervous force of his small compact body and his piercing eye which impressed one with his indomitable spirit even more than the substance of what was said. At over eighty he was hoping to embark on a fresh field of exploration from Kabul, where death claimed him. It was his wish that his body should rest amid the beautiful scenery of Kashmir.

BASIL GRAY.

Dr. M. Radford

THE passing of Dr. Maitland Radford, medical officer of health of St. Pancras, at the age of fifty-nine, is of more than local or professional significance. He was a rationalist, reared in a progressive if not

revolutionary atmosphere, with Shaw, Wells, William Morris and Bradlaugh as friends of his family. He was a nephew of Graham Wallas, whose influence he always gratefully acknowledged. Educated at Abbotsholme and University College Hospital, his career in public health was that of a successful and efficient sanitarian. But, as a close colleague of his has written, "he was not a man to allow the local trees to obscure his vision of the public health wood, or as he might have said, the public health jungle".

Widely and deeply read in literature, philosophy and economics, it was perhaps in health education in its widest sense that he found great satisfaction. The Central Council for Health Education, of which he was vice-chairman, owes much to him. But it was not the leaflet or the poster or the film which interested him most. It was rather the plan, the purpose of it all, the thought of the human personality rather than its physical frame.

He was a man of principles and ideas, preferring the long to the short view. Modest and urbane in manner, he was frank in the confession of his doubts, and both adamant and passionate in defence of principle. He was one of the few men of whom it can truthfully be said that nothing would induce him to say and do anything which he did not believe to be right. His defence of the secular approach to moral problems at a recent conference on venereal disease, at which the Archbishop of Canterbury was the principal speaker, will long be remembered by those who heard it.

In conference or conversation—he preferred conversation—the ideas simply tumbled out, or to be more accurate, shot out. Some he pursued himself, others he left his colleagues to pursue. Strange though the country through which they led the pursuer, they were worth pursuing. He prodded the conventional—but oh, so gently. He flicked the obstinate with a wit as innocent as it was penetrating. He 'rollicked' the reactionary with a mirth that was infectious. He was, above all, a thinker; and with the world as it is, that marked him out and adds to our sense of loss.

C. Hill.

We regret to announce the following deaths:

Dr. Carl Bonhoeffer, successively professor of neurology at Königsberg, Breslau and Berlin and one of the editors of the *Monatschrift für Psychiatrie*, *Allgemeine Zeitschrift für Psychiatrie* and *Zentralblatt für Neurologie und Psychiatrie*, aged seventy-five.

Mr. Christopher Dalley, president of the Institute of Petroleum, an authority on petroleum engineering, on January 27, aged sixty.

Dr. A. Stansfield, emeritus professor of metallurgy, McGill University, on February 5, aged seventy-two.

NEWS and VIEWS

Scientific Terminology

The enormous waste of human time and energy, nay also of human life, that has been caused by the use of wrong or vague words, and the misuse of good words, is well known to students of human thought through the ages. Many words have changed their meanings in the course of time, and new words have been adopted with ambiguous or multiple connotations. Though one would hesitate to suggest that the legal profession has been the chief perpetrator of such intellectual delinquencies, and of their *sequelæ*—for the theologians and philosophers must have run them very close—there is no doubt that the loose drafting of governmental Bills and Regulations, even up to the present day, has caused great confusion and, incidentally, served to redistribute wealth in a unilateral direction. As Mephistopheles remarked, "Mit Worten lässt sich trefflich streiten, Mit Worten ein System bereiten, Von einem Wort kein Iota rauben".

To-day most new words originate in the sciences or their applications, and many of them have been condemned or criticized owing to their lack of precision, their hybrid etymology, their ugliness or unwieldiness, or because they signify something different from identical or similar words used in common parlance. It has often been deplored that in Britain we have no institution or high authority to adjudicate on new words, like the French Academy does for France, albeit often with much delay; but there seems to be no reason why the scientific world should not take the bit between its teeth and appoint its own authority for rectifying bad words, including spelling, devising new words or deciding between rival suggestions. An 'omnibus' body, like the Royal Society, is clearly indicated to assume such a task. Through *ad hoc* subcommittees for groups of sciences, assisted by a few language experts, it could provide authoritative guidance, if not compulsory ruling, for scientific research workers, who are seldom as good at word-building as they are at 'things'. The main committee might also attack the problem of an international auxiliary language for use in science and technology.

Photographic Terminology

The above reflexions arise from a perusal of a letter addressed to the scientific Press by the editor of *Photographic Abstracts*, entitled "Microphotography and Photomicrography, and other Terminological Inexactitudes". Although these two terms, signifying the production of very small photographs and the photographic reproduction of very small objects, respectively, are clear enough to experts, they are confusing to other people, and one can support the author's plea for the standardization of these and similar terms. 'Micro-' and 'macro-', he suggests, should be used in photography with a definite quantitative meaning only, and one might go farther and suggest that when these prefixes are used for scientific words, they should bear a precise quantitative meaning, as in microgram and microhm, leaving their vaguer signification to popular words like microcosm, macrocosm and perhaps 'microcookery' (the cooking of war-time rations). The word 'radiogram' is one that needs immediate attention, as it has three distinct meanings: (1) a combination of radio-receiver and gramophone, (2) a telegram transmitted by radio, and (3) an X-ray photograph (also called a radiograph or a skiagraph). Probably (3) would be best for scientific use. The word 'radio' itself might be banned from scientific writing, for, at least etymologically, it might refer to any kind of radiation. But such difficulties as these are not to be solved offhand; they would best be considered by an authoritative body, as suggested above.

Water Resources of Great Britain

MR. H. U. WILLINK, Minister of Health, in a statement in the House of Commons on February 10, said that the Government proposes as part of its general reconstruction programme to introduce legislation making possible further Exchequer assistance for the extension of piped water supplies in rural localities. This will apply also to sewerage in such areas. A White Paper is in preparation outlining the Government's general proposals with regard to water; these will include provision for an adequate scientific assessment of resources and for the control and co-ordination of their use and distribution. It is hoped to issue the White Paper about the same time as the introduction of the Bill. It will deal with schemes on national lines.

Standardization of Non-Ionizing Radiations

THE Medical Research Council has appointed the following committee to advise and assist in promoting the quantitative study of the non-ionizing radiations, particularly in relation to their medical applications: Prof. H. Hartridge (chairman), Mr. P. Bauwens, Dr. R. B. Bourdillon, Mr. E. Rock Carling, Prof. J. A. Carroll, Mr. J. Guild (nominated by the Department of Scientific and Industrial Research), Prof. F. L. Hopwood and Prof. W. V. Mayneord (secretary). In 1928 and 1937 satisfactory units for the measurement of ionizing radiations were agreed internationally, and there is urgent need of a corresponding standardization for the non-ionizing radiations. Under this heading will be included infra-red, visible and short-wave wireless radiations, but it may be found advisable to deal also with ultra-violet and ultrasonic radiations, since none of these was covered by the earlier recommendations.

Transmission and Distribution of Electricity in Mines

A PAPER on this subject was read before the Institution of Electrical Engineers in London on February 9 by B. L. Metcalf. In the South Wales coalfield, where approximately 16 per cent of the total output of Great Britain is raised, the transmission and distribution of electricity introduces special problems owing to the hilly nature of the country. To give some idea of the potential demand at collieries to be obtained, the load for a typical group of collieries is analysed. Some notes are included on the choice of switchgear for collieries and on the influence on this choice of the proposed amendments to the Regulations for the Use of Electricity in Mines. Information is given regarding the damage to transmission towers during the ice storm of 1940, and a proposal is made to amend the regulations of the Electricity Commissioners governing ice-loading for conductors. A new design of cross-arm for a single-circuit 33-kV. overhead line is illustrated. Recommendations are made for the standardization of equipment required for the electrification of collieries.

The magnitude of the potential colliery electrical load should be given full consideration in any plan for the generation, transmission and distribution of electricity in any industrial mining area. Electrification of the collieries in any area would be simplified and cheapened by greater standardization of the sizes of units adopted. Standardization could be applied with advantage to switchgear, transformers, compressors, haulages, winder drums, transmission-line cross-arms, cable sizes, voltages, etc. The subject of pit-head generation is touched on only as it affects the general problems of transmission and distribution, but it is one which demands full and thorough technical investigation in all its aspects, and in relation to the location of washeries, existing generating stations and transmission lines, coal freights and other local industrial loads.

Man's Influence on Seismic Movements

WALTER KNOCHE has an article with the title "La Accion Humana Como Una Causa Posible De Liberar Movimientos Sismicos" in *Anales de la Sociedad Cientifica Argentina* (135, Ent. IV and V, 1–41; 1943) which suggests a number of ways in which the progress of civilization can influence earth movements. A few of these will be referred to in the following brief summary. The weight of matter transported by the great rivers and deposited at their mouths depends on the denudation which takes place, and this, in turn, depends on the nature of the soil, the presence of vegetation, and other factors which are under the control of man. Variations in isostasy in the deltas of rivers as well as in the regions of denudation are, therefore, indirectly due to human agency. Then again it is pointed out that oscillations in the earth's axis might be produced by the displacements of matter through fluvial transportation, and this latter depends on man's interference with the vegetation. Another important factor is fires which destroy vegetation and so release a considerable weight over certain parts of the earth's crust. The loss of weight on land appears as an increase in the oceans, which receive a great portion of the burnt vegetation in the form of carbon and water. The weight of great cities with their inhabitants, such as San Francisco and Tokyo, is able to originate earth movements, more especially in those regions of the earth where there is a certain amount of instability. It seems possible to conduct research on the influence of re-afforestation in mitigating the danger of denudation and devastation on the earth's surface, and in this way to estimate the extent of the human factor in the production of earth disturbances.

The Dominion Observatory, Wellington

THE report for the year ended December 31, 1942, of the Dominion Observatory, Wellington (Bull. No. *R*28) deals chiefly with time service and seismology. During most of the year the control of the time service was greatly facilitated, enabling additional check time signals to be received from Greenwich and Washington. The clocks were seriously affected by local earthquakes on June 24, August 2 and December 2, but they suffered no permanent damage. The free pendulum was frequently disturbed by local earthquakes, and investigations showed that marked changes of rate are not due to defects in the clock mechanism but are associated with one or other of the following causes: (1) violent fluctuations in barometric pressure; (2) changes in the direction of local ground tilt; (3) local earthquakes. The severe outbreak of seismic activity in the Wairarapa district on June 24, 1942, followed by severe aftershocks on August 2 and December 2, has been already referred to, and a considerable number of subsidiary shocks also occurred, six hundred being recorded at Wellington. On June 27 a shock took place the epicentre of which was near White Island. The focal depth, 230 miles, was the deepest origin so far recorded in

the New Zealand region. Another notable occurrence was a shock on November 1, centred in the south-east Tasman Sea, about 150 miles off the Milford Sound coast. Information is given in the bulletin on various other matters connected with the different seismographic stations and their instruments, on the research carried out on the distribution of earthquake activity in New Zealand, and on matters of general interest.

War and Rheumatic Fever

According to an article in the September issue of the *Statistical Bulletin* of New York, war conditions generally favour an increase of rheumatic fever in the armed forces. This was seen not only in the War of 1914–18 but also in the present conflict, in which many cases have been reported among the younger men enlisted. Susceptible individuals are usually attacked shortly after reporting for duty. About 40 per cent give a history of infection in childhood; but in a significant proportion there is no history of a previous attack. The seasonal distribution of the cases is typical, the peak being reached in the late winter and early spring. In the great majority of cases there is a history of upper respiratory infection or of scarlet fever. In the general population, however, both in the United States and in England, there has been a decline in rheumatic fever and rheumatic heart disease during a war period, the decline being attributed to decreased amount of poverty as a result of full employment, the better feeding of children, especially the increased provision of milk, and the evacuation of children from metropolitan areas.

Names of Biological Colours

Prefaced by a brief discussion, H. A. Dade (Mycological Papers No. 6: Colour Terminology in Biology. Pp. 25. Kew: Imperial Mycological Institute, 1943. 3*s*. 9*d*. net) has provided a useful dictionary list of the names of colours, cross-referenced as to synonyms, that are or may be employed, particularly as trivial names, in biology. Appended to this is a list of the words indicative of tone or texture, and two charts which give the position of the names in relation to Ridgway's "Chromatic Scale". This should prove very useful to systematic biologists, in particular those without adequate knowledge of the Classical languages, for quite frequently trivial names supposed to be indicative of colour are incorrectly applied, and sometimes so badly that they are misleading. It is to be hoped that now such an aid is available this will not occur so often in the future.

Equilibrium Diagrams of Binary Alloy Systems

"The Equilibrium Diagram of the System Aluminium-Zinc" is the title of the first of a new series of publications which the Institute of Metals proposes to issue of up-to-date equilibrium diagrams of binary alloy systems. Each of the series will consist of the diagram reproduced on a large scale and based on the most reliable work in each phase-field, a table providing all the important data connected with this diagram, critical notes and a list of references. This initial publication, the work of G. V. Raynor, appears to satisfy all these points in an excellent manner, and whets one's appetite for the three others so far promised, on the copper-tin, copper-zinc and copper-aluminium alloys respectively. It is available from the Institute at 4 Grosvenor Gardens, S.W.1 (6*d*. post paid).

Thoughts on Reconstruction

The April, June and September 1943 issues of the *Krisson Bulletin* contain a series of articles well designed to encourage the development of a more scientific outlook generally. The first, "A Plea for Scepticism", should encourage a more critical attitude to some of the proposals for reconstruction and particularly to political theory. It includes a useful little bibliography. In the following issue are printed eleven paragraphs of "The Universal Rights of Man" from a pamphlet by Mr. H. G. Wells to be published later. This is a development from the "Declaration of the Rights of Man". This statement of the universal rights—the right to live, protection of minors, freedom to work, right to earn money, right to possess, freedom to go about, right to know, personal liberty, freedom from violence—which are in the nature of man and cannot be changed, but could be made the basis of a new and happier way of human life, is accompanied by an appeal not to take them for granted but to work for them and to guard them. The third article, "Educated? It *is* my Business", after quoting F. Sherwood Taylor's "The Century of Science", pleads for an attempt to understand our environment and to take an intelligent place in human organization.

Announcements

Dr. E. F. Armstrong has been appointed chairman of a commission appointed by the Conference of Allied Ministers of Education to report on the problems involved in the supply of scientific equipment to the occupied countries when they have been freed.

The Council of the Institution of Naval Architects has awarded the premium of the Institution for the year 1943 to Dr. J. F. C. Conn, for his paper "Marine Propeller Blade Deflection".

A research scholarship of the value of £400 a year and tenable for two years has been offered by the Wrought Light Alloys Development Association to encourage and facilitate research in the application of light alloys to ship construction. The scholarship will be administered by a committee of the Institution of Naval Architects and it is hoped to make the award in September. Full particulars of entry, which closes on July 31, can be obtained from the Secretary, Institution of Naval Architects, 10 Upper Belgrave Street, London, S.W.1.

The Chancellor of the Exchequer has stated in a written Parliamentary reply that the Government, after considering a report from the University Grants Committee, has decided to maintain the provision for universities and colleges in the Estimates for 1944 at its existing level.

The Council of the American Astronomical Society has awarded the Annie J. Cannon Prize for women astronomers to Miss Antonia C. Maury of Hastings, N.Y., for her distinguished work at the Harvard College Observatory in the early days of spectral classification. Miss Maury at the turn of the century devised her own system of classifying the spectra of the stars on the basis of detailed descriptions of their characteristics as obtained from high-dispersion spectra. These details have since been shown to have great significance in revealing the physical characteristics of the stars.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

β-Radiation from Active Phosphorus and Sodium

IN order to investigate the β-radiation from active phosphorus, phosphorus pentoxide was irradiated with 5 MeV. deutrons (current approximately 40 μ A.) in the cyclotron of this Institute. A very small fraction of the sample (about 0·01 mC.) in the form of $Mg_2P_2O_7$ was placed between two foils of about 0·02 μ thickness, the preparation forming a narrow strip 7 mm. × 0·5 mm. It was then introduced into a β-spectrograph of the lens type[1] with high intensity and good resolution (in this case 1·9 per cent), and provided with a very thin foil (0·2 μ) in front of the Geiger-Müller counter. To obtain the true distribution curve, the number of particles counted must be divided by the corresponding value of $H\rho$. The spectrograph was calibrated by using the I line of thorium B, the energy of which had been determined as $H\rho = 1750$ in the semicircular spectrograph of the Institute.

If we plot $\left(\frac{N}{f}\right)^{1/2}$ against $\sqrt{1+\eta^2}$ $\left[\text{where } f(z,\eta) = \eta^2 \cdot \frac{2\pi y}{1-e^{-2\pi y}};\ y = z \cdot \frac{\sqrt{1+\eta^2}}{137\eta};\ \eta = \frac{H\rho}{1700}\right]$ we should, according to Fermi's formula of β spectra, obtain a straight line. The Fermi diagram obtained is seen in Fig. 1. Evidently the curves are quite straight except at lower energies. For energies where $\sqrt{1+\eta^2}$ is less than 2, the experimental curves give more particles than are predicted by the Fermi formula. It is possible that this can be explained by the occurrence of scattering in the backing foil or more probably in the source itself, a process which should undoubtedly give rise to low-energy electrons. In view, however, of the thinness of the foils and narrowness of the source, this can scarcely account for the very pronounced excess of low-energy electrons in comparison with the theoretical number. According to our conceptions of the β-emission by phosphorus, this constitutes a so-called 'forbidden transition'. The Fermi formula is rather developed on the assumption of a permitted transition and, according to Fig. 1, probably cannot explain the energy distribution in this case.

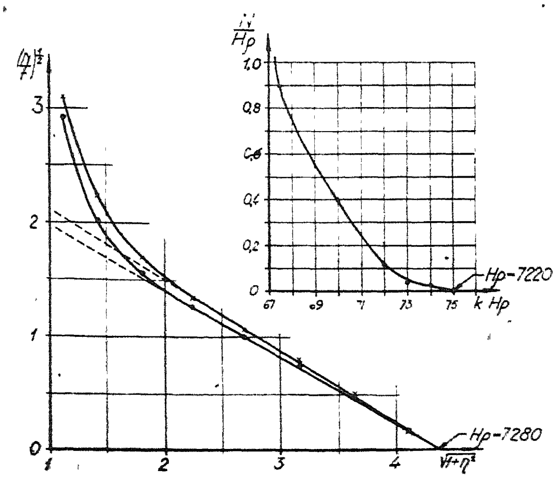

FIG. 1.

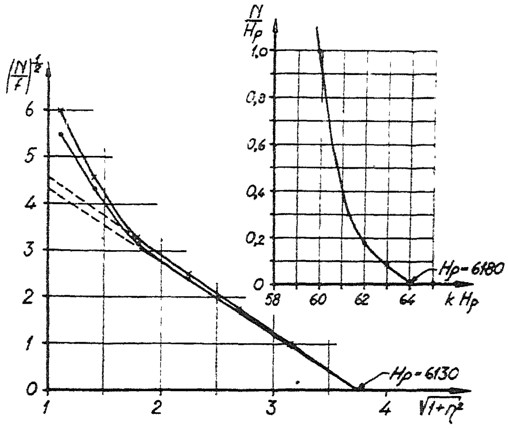

FIG 2.

The straight part of the Fermi curve cuts the axis at $H\rho = 7280$, which fits well with the direct determination of the upper limit (corrected for the finite power of resolution) $H\rho = 7220$ or $1{\cdot}71 \pm 0{\cdot}02$ MeV., which is marked in Fig. 1. The value for the upper limit seems to be in good agreement with determinations by Lawson[2] ($H\rho = 7210$) and Lyman[3] ($H\rho = 7150$) made by the semicircular method.

With sodium, ^{24}Na, a β-radiation is emitted which also corresponds to a forbidden transition. To study this radiation, sodium hydroxide was irradiated in the cyclotron for some hours and a very small fraction of the sample in the form of sodium chloride was treated as before and introduced into the β-spectrograph. After correction for the falling off of the intensity due to the disintegration ($T = 14{\cdot}8$ h.) the two Fermi curves in Fig. 2 were obtained, where the upper limit is also marked. Apparently the Fermi curve is similar in shape to that for phosphorus, with more low-energy electrons than might be expected from the theory of permitted transitions. When $\sqrt{1+\eta^2}$ is greater than 1·8, the curve is, however, a straight line and cuts the axis at $H\rho = 6130$, where the direct determination gives $H\rho = 6180$ or $1{\cdot}41 \pm 0{\cdot}02$ MeV. This value agrees well with the value obtained by Lawson[2], $H\rho = 6150$, but disagrees with that obtained by Kurie, Richardson and Paxton[4] with the cloud chamber (1·7 MeV.).

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1 Siegbahn, Kai, *Ark. f. Mat., Astr. o. Fysik*, **30** A, No. 1 (1943).
2 Lawson, J. L., *Phys. Rev.*, **56**, 131 (1939).
3 Lyman, E., *Phys. Rev.*, **51**, 1 (1937).
4 Kurie, Richardson and Paxton, *Phys. Rev.*, **49**, 368 (1936).

Nuclear Disintegrations Produced by Cosmic Rays

SINHA has recently published[1] a remarkable cloud-chamber photograph of a four-pronged disintegration of an oxygen nucleus produced by a neutral cosmic ray particle. From the appearance of the tracks, he concludes that the two outer ones (tracks 1 and 4) are due to particles of a charge higher than that of an α-particle. The two inner tracks (2 and 3) appear to be due to doubly charged particles. Their end portions are crossed by thin ionization tracks. After

considering the possibility that this is due to an extremely rare chance coincidence, Sinha suggests that the thin tracks may be interpreted as pairs of (oppositely charged) electrons emitted from excited nuclei at the end of their paths. He emphasizes, though, that it is difficult to understand why the electrons should be emitted in diametrically opposite directions.

If we grant that tracks 1 and 4 are due to fast-moving nuclei with Z equal to or greater than 3, tracks 2 and 3 could be due only to singly charged particles (hydrogen isotopes), if conservation of charge is assumed in the disintegration of the oxygen nucleus ($Z = 8$). However, our present knowledge of the properties of the hydrogen isotopes leaves little room for the possibility that they may have excited states of sufficiently long life to emit electron pairs at the end of their paths.

If we still assume a causal relationship between the thin tracks and tracks 2 and 3—which will remain an open question until it is decided by further experiments—we are forced to conclude that a hitherto unknown process takes place. In such a situation we have only the most generally valid principles, like conservation of charge and momentum, as a guide. The simplest hypothesis compatible with these principles which would account for Sinha's picture appears to be the following. In the collision of a neutral cosmic ray particle with an oxygen nucleus, two new particles of opposite charge are created (2 and 3), and the oxygen nucleus broken up into two parts (1 and 4). To judge from their great ionizing power, the particles 2 and 3 have each double electronic charge and a mass which is considerably larger than that of two electrons. They are therefore intrinsically unstable, but apparently have a sufficiently long life, so that they do not decay until they have lost their kinetic energy. Each then decays into a pair of electrons, both negative in one case, and both positive in the other. Conservation of momentum requires that the decay electrons are emitted in diametrically opposite directions, and with equal velocities (equal specific ionization).

Disintegrations of nuclei by cosmic rays, or 'stars', have been studied by many observers in photographic emulsions. These stars appear to consist of proton and α-particle tracks, yet different observers disagree on the relative frequency of these particles[2]. When the number of particles in the 'star' is small, this type of disintegration may be pictured as a Bohr evaporation process[3]. However, where the number of singly or doubly charged particles approaches or exceeds[4] the atomic number of the original nucleus, it would seem necessary to assume the creation of new strongly ionizing particles. Sinha's picture may give a clue to the nature of these particles, which may have an ionizing power intermediate between that of a proton and that of an α-particle (for equal range). In this case they might have been identified with protons by some observers and with α-particles by others.

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[1] Sinha, M., Nature, 152, 568 (1943).
[2] For a detailed bibliography on this work, see Shapiro, M. M., *Phys. Rev.*, 61, 115 (1942).
[3] Bagge, E., *Ann. Phys.*, 39, 512 (1941).
[4] Blau, M., Nature, 142, 613 (1938). Idanoff, A., Nature, 143, 682 (1939).

Relationship between Dielectric Constant of Liquids and Solids and Dipole Moments

It has been found that the molar electric susceptibility of liquids,

$$P = (\varepsilon - 1) \times M/d = 4\pi N(\alpha + \mu^2/kT),$$

where ε is the dielectric constant of the pure liquid and μ the moment. The derivation of this follows if we regard the dipole as needle-shaped. This assumption is inherent in the Debye equation for gases. In solids and liquids, owing to hindered rotation, molecular orientations are distributed according to the Boltzmann function μ^2F/kT, because the dipoles can become oriented only in two directions, along and opposite to the direction of the electrical field. This relationship is found to hold good for all normal liquids from hydrogen bromide ($0{\cdot}8D$) to nitrobenzene ($4{\cdot}2D$), and for solids such as hydrogen chloride, hydrogen sulphide, hydrogen bromide and hydrogen iodide which show molecular rotation at low temperature. In the case of associated liquids and divalent salts, kT is $\frac{1}{2}$. In ionic crystals the moment calculated from the dielectric constant has to be multiplied by the co-ordination number to give the same value as obtained by the molecular beam method. The results show that the alkali halides are 2/5 ionic or 'dipolar' in the gaseous and 1/15 in the solid state.

Details of this work will be published jointly with Miss Nagamani and Mr. Sathe.

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Levine's Hypothesis of Maternal Iso-immunization

My recent letter on "Mutation and the Rhesus Reaction"[1] has provoked two replies. In one of them[2], Prof. J. B. S. Haldane raises an objection with which I hope to deal elsewhere at length when pressure of official duties is less exacting. In the course of the other[3], Prof. R. A. Fisher, R. R. Race and Dr. G. L. Taylor say that they "dissociate ourselves from the statement that 'Levine's hypothesis postulates a form of adverse selection . . .'". Levine's hypothesis postulates that the blood of an $Rh(-)$ mother who bears $Rh(+)$ offspring by an $Rh(+)$ father produces an antibody which plays havoc with the red cells of the fœtus. The result may be miscarriage, stillbirth or neonatal hæmolytic anæmia with possibly fatal consequences. Since such offspring are necessarily heterozygous, the hypothesis that erythroblastosis fœtalis, a condition lethal in a certain percentage of cases, is due to maternal iso-immunization also implies the existence of the adverse form of selection with which Haldane's letter mainly deals, as does the article of Wiener cited therein. Owing to present difficulties arising from dispersal of libraries for safe storage, I was not aware of the existence of Haldane's paper[4] in which he develops several conclusions which I have derived independently, though it now appears later. Otherwise I should have cited his own prior treatment of the type of adverse selection implicit in Levine's hypothesis.

The main point I was concerned to stress in the latter half of my letter may have eluded Prof. Fisher and his colleagues because it touches on a misunderstanding which, though very elementary, is also very prevalent in medical circles, with results of some public

interest. Again, it is one which Haldane deals with at length in his paper. For the reason stated, I was not aware that he had done so until after my own letter appeared. Levine and his co-workers do not explicitly assert that the combination $Rh(-)$ mother and $Rh(+)$ fœtus constitutes a *sufficient*, in contradistinction to a *necessary*, condition for the occurrence of erythroblastosis fœtalis; but their writings are certainly open to that interpretation, and I have recently met several eminent clinicians, including two responsible officers of blood transfusion depots, who interpret Levine's hypothesis in the former sense. Now the approximate incidence of $Rh(+)$ offspring of $Rh(-)$ mothers is easy to calculate. Indeed such calculations appear in preliminary notes of the pioneer work being done by the Galton Laboratory Serum Unit. They show that such offspring are vastly in excess of any recorded statistics of the incidence of neonatal hæmolytic anæmias, even after generous inflation of the figures by due allowance for fœtal deaths.

There are several possible reasons for this. I have suggested one, and could suggest several others. Haldane[4] offers the interesting hypothesis that women differ individually with respect to permeability of the placenta. It would therefore be interesting to know if an $Rh(-)$ *O* woman who had a history of miscarriage in a first marriage with an $Rh(+)$ *O* man would sustain the family tradition in a subsequent union with an $Rh(-)$ *A* man. In any event, there seems to be little doubt about the truth of either of two propositions: (*a*) that the genotype combination of the mother and offspring does not disclose a *sufficient* condition for the occurrence of erythroblastosis; (*b*) that it does disclose a *necessary* condition for a very high percentage of cases.

The distinction, if elementary, has some practical significance at the present moment, because voluntary donors at blood transfusion centres may be misled by popular or semi-popular expositions of Levine's important discovery, including his own in a recent issue of the *Journal of Heredity*. Indeed, my interest in its genetic implications was first excited by hearing of a Rhesus-negative young woman who had withdrawn her promise or offer of marriage when her donor fiancé proved to be $Rh(+)$. I cannot improve on Haldane's own statement of the practical issue in his paper on the adverse form of selection which Levine's hypothesis implies: "it is obviously futile to urge that all *rh.rh* women, some 14% of the total, should be prevented or dissuaded from marrying the *Rh.Rh* and *Rh.rh* men who make up the remaining 86%. Research on the etiology of high placental permeability is an urgent problem. If it is largely due to a particular gene substitution, the gene in question must be much rarer than *rh* and therefore a more suitable target for negative eugenics."

With reference to the statement that the Galton Laboratory Serum Unit now postulates seven alleles, of which "not more than four are Rhesus positive", it suffices to say this. If progress continues at this encouraging tempo, the *Rh* locus may yet prove to be as unstable as I have ventured to suggest.

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Jan. 27.

[1] NATURE, **152**, 721 (1943).
[2] NATURE, **153**, 106 (1944).
[3] NATURE, **153**, 106 (1944).
[4] *Ann. Eug.*, **11**, 333 (1942).

Crossing-over in the Males of *Drosophila subobscura*

MEIOSIS in the males of the higher Diptera is characterized by absence of chiasmata. This means that as a rule genetical crossing-over occurs only in females. There are, however, a few exceptional families in *Drosophila melanogaster*[1,2] and *virilis*[3], the constitution of which can only be explained as due to crossing-over in the father. In these cases the exceptional offspring occurred in batches rather than singly. It was therefore supposed that crossing-over had taken place in one of the early spermatogonial divisions, though there is no cytological basis for this assumption.

I have found, in *Drosophila subobscura*, cytological evidence that crossing-over can take place in males during meiosis. Of three hundred testes from stocks containing 1–3 pairs of large autosomal inversions, one contained a lobule in late first anaphase, in which eight of the thirty-two nuclei in division showed single chromosome bridges, one a bridge and a fragment, and another two bridges. This is evidence that crossing-over had taken place in ten out of thirty-two cell divisions, because single crossing-over in inversions which do not include the centromere results in dicentric and acentric fragments. The dicentric fragments form bridges either at the first or second meiotic division, and the acentric fragments are lost.

Thus a male Drosophila still has the possibility of forming chiasmata. Normally, however, the meiotic chromosomes first emerge from a diffuse condition in the diakinesis stage of prophase; the pachytene stage where chiasmata are formed in a normal meiosis has never been seen. A slight alteration in timing, which affects all the cells in a lobule simultaneously, may permit chiasma formation, thus showing that the properties of the chromosomes have not changed radically. This results in the occasional appearance of a number of cross-over individuals in the progeny of a single heterozygous male.

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Jan. 25.

[1] Muller, *Amer. Nat.*, **50** (1916).
[2] Friesen, *Biol. Zbl.*, **54** (1934).
[3] Kikkawa, *Proc. Imp. Acad. Japan*, **9** (1933).

Fluctuations in Seaweed

RECENTLY, several communications have appeared in NATURE relating to seaweeds, their properties and uses. It is apparent that their commercial potentialities are much more considerable than has hitherto been realized, and that this is not merely a temporary effect of war needs. Obviously, progress must depend on the continuance of adequate supplies, yet little has been said as to the need for the study of their distribution, conservation and protection in favourable localities.

There are, indeed, two opposing views among those who have any opinion in the matter. The one is a firm belief that supplies are 'inexhaustible'; the other, that they are, like land crops, subject to serious fluctuations unless proper precautions are taken. It may be well to consider how far these views are based on general impressions or founded on fact.

In his lecture to the Royal Society of Arts in 1884 on "The Economic Aspects of Seaweeds", the distinguished chemist, E. E. C. Stanford, stated that the supply of material (for commercial purposes) was "almost unlimited". In a much more recent, though undated, brochure, entitled "Manucol", it is claimed (p. 5) that "Certain marine plants form an inexhaustible source of raw material for alginate production". This view has doubtless been the more readily accepted, since at certain times and places vast quantities of weed are thrown up by the tide after rough weather. The frequent lack of means to utilize them to the full would give the impression of great surplus. It is known that important substances for plant growth, such as nitrates and phosphates, undergo seasonal fluctuations in sea-water, being much depleted after spring growth and regenerated naturally in the autumn. One source of replenishment is the soil and detritus washed down from land by streams. These findings, however, do not relate at present to places with the largest yield of seaweed, and the cumulative effect of the complete removal of many thousands of tons of seaweed periodically is quite unknown.

The alternative view is borne out by experience in regions where the utilization of seaweed has been for long a local industry of importance. For example, on the coasts of Brittany harvesting seaweed has been subject to strict regulation for more than a century, while in Japan, still more vigilance and supervision has been practised since the expansion of the seaweed industry into a considerable export trade, during the present century. An account given by Yendo to the Royal Society of Dublin in 1914 gives some idea of the reasons for these developments. It was found, for example, that with repeated harvesting, certain beds of Laminarias became overgrown with a rapidly spreading submarine flowering plant. The prostrate shoots of these plants had to be cleared by hand before the Laminarias could be gradually re-established. By proper attention between harvestings, this condition could be prevented, and instructions were issued and enforced in the areas concerned. Seaweed 'farms' for the cultivation of Fucus and Porphyra were also established and apparently brought to a high degree of efficiency.

There are also certain general considerations which point in the same direction. The large deposits of drift seaweed which occur from time to time are frequently not reported, much less understood. Laminarias flourish in quantity on submerged reefs away from human habitation. Organized attempts to utilize them, if leading to the growth of communities of any size, with the necessary sewage disposal, may have unforeseen effects. Moreover, seaweeds, like other plants, have their diseases, and crops must be spaced to allow for effective regeneration. Other circumstances, such as the accumulation of oil residues from shipping, or the shift of tides, may alter productivity in particular areas. At present we have no effective means of estimation of quantity in relation to quality or to seasons.

On these and many other questions arising from the commercial exploitation of seaweeds, we have little or no information. Only a long-term policy of planned investigation can provide answers to some of them, and it has been well said that such investigation should be teamwork, including marine zoologists as well as botanists. It should not be forgotten, however, that knowledge of seaweeds is at a relatively low level, even on the systematic side. Much remains to be done before we shall have a real understanding of their life and their reactions to environment.

I understand that already a falling off in the amount of seaweed has been alleged by collectors in certain very productive regions. Is this due to faulty memories, or to lack of adequate means of estimation of quantity (comprising depth as well as extent, on the shore)? Or is it, on the other hand, a timely warning that the estimation and conservation of natural sources is already urgent? If the latter, much investigation will be needed to establish the principles upon which such a policy should be based.

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Jan. 4.

Spore-forming Bacteria causing Soft Rot of Potato and Retting of Flax

BACTERIAL soft rot of vegetables and the retting of flax are both due to decomposition of the pectin complex in the middle lamella, in the former case resulting in a loss of cohesion between the cells of the vegetable in the area invaded by the causal organism, and in the latter case resulting in a dissolution of the layer which binds the fibre bundles to the remainder of the cortex. It seems likely, therefore, that some bacteria may be furnished with the necessary enzymes to enable them to bring about both these changes.

In the course of an investigation carried out at this laboratory on the process of retting flax in tanks, large numbers of samples of retting liquor and of flax, taken at various stages during different processes of retting, were submitted to bacteriological examination. Tubes of nutrient broth, each containing a small cube of sterile potato, removed aseptically from the interior of a tuber, were found to be a suitable medium for testing for bacteria which produce soft rot of potato. Successive ten-fold dilutions of the retting liquor, or of an extract of the flax, were made in sterile Ringer solution, and duplicate quantities of 1 ml. from each dilution were inoculated into separate tubes of the potato medium, which were then incubated at 30° C. and were examined at intervals during a period of fourteen days. Soft rot of potato was detected by prodding with a stiff nichrome wire. It was found that, at or near the completion of the retting, soft rot was consistently produced by high dilutions of the liquor or of the flax extract, the 'count' of the causal organisms varying to some extent with the method of retting, but usually being between 10^4 and 10^8 per ml. of liquor or per gram of moist flax. Tests with similar media containing vegetables other than potato showed that bacteria causing soft rot of turnip were also consistently present, but that carrot or parsnip gave uncertain results.

It appeared from a large number of tests, made with tubes in which the potato had been rotted, that in the flora of retting liquor or of retted flax, ability to cause soft rot of potato was confined to spore-bearing bacteria, that the anaerobic spore-bearers were usually predominant among the causal organisms, but that aerobic spore-bearers with this characteristic were sometimes present in appreciable numbers. This observation may be compared with Ruschmann's statement[1], which is borne out by the literature, that

all aerobic and anaerobic retting organisms are spore-formers.

From two different rets a spore-bearing aerobic bacillus was isolated in pure culture; this produced soft rot in potato under laboratory conditions. The morphology and reactions—formation of acid and acetoin, but no gas, from dextrose, rapid liquefaction of gelatin, digestion of milk, and strong diastatic power—of the two cultures were identical and conformed with those of *B. subtilis*. Their identity with this organism was confirmed by Dr. T. Gibson of Edinburgh, to whom subcultures were sent.

Testing the ability of a pure culture to ret flax is rendered difficult by the fact that the flax used as a substrate may be appreciably altered in character if it is sterilized by heat. To obviate this difficulty an enzyme powder, capable of acting in the presence of an antiseptic which inhibits bacterial growth, was prepared from each of the two strains of *B. subtilis* by the following method, which is similar to that described by Dox[2].

A mass growth was obtained by seeding the surface of potato-mush agar sloped in ten 1-litre bottles. After incubation for two days at 30° C., the growth was washed off with water and the aqueous suspension was filtered through a Buchner funnel. The residue on the filter paper was ground in a large volume of acetone and left immersed for ten minutes. The acetone was filtered off at the pump and the residue was similarly treated, first with acetone for two minutes and finally with ether for three minutes. The residue after filtration was dried in a thin layer at 37° C. for two to three hours, and was then ground to a fine greyish-yellow powder which was tested as follows:

(1) 0·2 gm. of the powder was ground with 5 ml. of distilled water and the suspension was transferred to a test tube. Several thin disks of freshly cut potato (approximately 1 cm. in diameter and 1 mm. in thickness), and 0·2 ml. of toluene, were added to the suspension, which was thoroughly shaken. A control tube without the enzyme powder was prepared at the same time and both tubes were incubated at 30° C. When examined after 18 hours, the disks of potato in the enzyme preparation showed complete soft rot, disintegrating easily when manipulated with a stiff wire. Disks in the control tube were unaltered.

(2) Flax stems were cut into uniform lengths of about 4 in., and were packed tightly into a glass cylinder about 1 in. in diameter. A suspension containing 2·5–3 gm. of the enzyme powder and 2 ml. of toluene in 50 ml. of distilled water was poured into the cylinder until the flax was completely immersed. A control cylinder without the enzyme powder was prepared in the same way, and both cylinders were incubated at 30° C. Progress of retting was followed at intervals by means of the 'loose core' test, and a small quantity of toluene was added daily to each cylinder. The flax immersed in the enzyme preparation was completely retted in three days, the flax in the control cylinder being unchanged.

These experiments show that *B. subtilis* produces enzymes which rot potato and ret flax. The fact that the process of retting in tanks on a large scale is accompanied by the growth in large numbers of spore-forming bacteria which produce soft rot of potato suggests that they may also be largely responsible for the retting. It may be noted that ability of spore-forming bacteria to cause soft rot of potato, which Dowson[3] recorded for *B. polymyxa*, is certainly not, under laboratory conditions, confined to that species.

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[1] Ruschmann, F., *J. Text. Inst*, 15, T61 and 104 (1924).
[2] Dox, A. W., U.S. Dept. Agric. Bur. Anim. Ind., Bull. 120 (1910).
[3] Dowson, W. J., NATURE, 152, 331 (1943).

Reported Asymmetric Synthesis of Santonin

THE announcement that santonin containing approximately 93 per cent of the *lævo*-rotatory variety (naturally occurring santonin is *lævo*-rotatory) has been obtained by Paranjape, Phalnikar, Bhide and Nargund[1] during the synthesis of santonin without apparently any asymmetric influence at any stage of the synthesis is of unusual interest. The realization of such a result cannot be excluded on the evidence given. On the other hand, it is contrary to all analogous experimental results so far recorded that methylation of an externally compensated and optically inactive compound should proceed at different rates on the *lævo*- and *dextro*-constituents of the externally compensated substance even when the asymmetric carbon atom is involved. It is possible, however, to conceive cases when a difference in reaction velocities of the *lævo*- and *dextro*- varieties of an externally compensated compound may be realized.

So far as present conditions permit, it would be useful if as large a number as possible of experienced investigators should repeat the methylation of 2-formyl*cyclo*hexanone under various conditions, and determine whether or not the resulting 2-methyl-2-formyl*cyclo*hexanone is or is not optically active. If any positive evidence is obtained the statistical analysis of the results would be interesting.

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Chemistry Department,
Guy's Hospital Medical School,
(University of London),
London, S.E.1. Jan. 30.

[1] NATURE, 153, 141 (1944).

Microbiological Assay of Riboflavine

PROF. R. H. HOPKINS[1] has added to Dr. Barton Wright's and Mr. Booth's[2] reply to the comments made by Happold[3] on the microbiological technique for the assay of riboflavine and has included a criticism of the work published by us[4]. Both communications concentrate on the point made by us regarding the amount of calcium in the medium, while ignoring other points of criticism which we made. Barton Wright and Booth state that the calcium effect is due to buffer action, this being incorrect, while Hopkins, relying on the papers of Holt, La Mer and Chown[5] on calcification in bone and on the solubility product of $Ca_3(PO_4)_2$ in water or in serum, states that the calcium concentration could not be influenced appreciably by added calcium chloride at *p*H 6·6–6·8. It should be mentioned that Holt *et al.* state that the solubility product is affected enormously by the presence of other salts and that a complex solution of amino-acids is very different from serum (protected by these workers against bacterial proteolysis). They also state "the precipitation of tertiary calcium

phosphate occurs so slowly that solutions of this salt may remain supersaturated for many days".

We are not concerned with theoretical considerations, we can but record our findings made frequently and separately by us and using an acid hydrolysate of casein, similar in all respects to that of J. H. Mueller[6] and to that of Snell and Strong[7]. We have also indicated, from a review of the literature, that mineral requirements may be modified by the pattern and amount of growth factors added to the medium.

But Prof. Hopkins asks a question by implication: if little or no precipitation occurs immediately after the addition of $CaCl_2$ to the cold sterile medium, what happens after seventy-two hours? In our experience (in uninoculated controls), very little. It must be remembered also that we are not dealing with simple solutions; there is a rich variety of amino-acids present in the medium, cells are growing rapidly and glucose is being metabolized. Phosphates are utilized in both these processes and are removed from the medium, and finally the pH of the medium falls. All these factors will tend to increase the solubility of calcium, which in our experiments is never precipitated.

FRANK C. HAPPOLD.
F. W. CHATTAWAY.
MARY SANDFORD.

Biochemical Laboratories,
School of Medicine, Leeds, 2. Jan. 12.

[1] Hopkins, R. H., NATURE, **152**, 724 (1943).
[2] Barton Wright, E., and Booth, R. G., NATURE, **152**, 414 (1943).
[3] Happold, Frank C., NATURE, **152**, 414 (1943).
[4] Chattaway, F. W., Happold, F. C., and Sandford, M., *Biochem. J.*, **37**, 298 (1943).
[5] Holt, E., La Mer, V. K., and Chown, H. B., *J. Biol. Chem.*, **64**, 509 (1925).
[6] Mueller, J. H., Klise, K. S., Porter, E. F., and Graybiel, A., *J. Bact.*, **25**, 509 (1933).
[7] Strong, F. M., and Snell, E. E., *Ind. Eng. Chem., Anal. ed.*, **11**, 346 (1939).

Cellulose Acetate Mounts for Rock and Mineral Fragments

EMBEDDING rock or mineral particles in a uniform thin sheet of cellulose acetate facilitates their optical examination, transport and storage, especially during the field study of graded concentrates derived from detrital or crushed rocks.

More than a hundred times the quantity of such particles can be mounted together than is possible in any normal Canada balsam/glass mount, while preserving all significant microscopical advantages of the latter. This fact enables more accurate quantitative mineralogical analyses of certain sands to be made, for example, by accommodating in a single mount the whole heavy-mineral concentrate from a bulk-sample of greater volume than it has been convenient to study in most cases hitherto. Areas of the film containing grains of critical importance can be marked with ink, greasy crayon or gummed paper masks, or removed for special treatment with scissors, a knife or razor blade.

The substance of the sheet is colourless, transparent and isotropic when unstrained, with a refractive index of about $N_D^{20°}$ 1·4, depending upon the exact composition of the dispersion. It is light in weight, very flexible, insoluble in water and does not crease, crack or tear, even when handled comparatively roughly. In composition it is identical with that of the laminar moulds used by me for studying the finer structures of rock, mineral and metal surfaces[1].

To prepare such a mount, a cold dispersion of cellulose acetate in one part by volume of tetrachloroethane and two parts by volume of 'Cerric Thinner T.10' (Cellon, Ltd., Kingston-on-Thames), containing about 20 per cent (of the weight of cellulose acetate) of a plasticizer such as triphenylphosphate or dimethyl-phthalate, is flowed over a levelled sheet of clean plate glass, say, 23 cm. × 10·5 cm. × 0·6 cm., to a depth of 0·1–0·15 cm., the latter depending on the maximum diameters of the particles concerned. Immediately this has been done, the sieved rock or mineral powder, either before or after separation into fractions, is moistened with tetrachloroethane and shaken as evenly as possible over the dispersion layer, into which it sinks.

In about eight hours the compact film remaining after volatile parts of the dispersing medium have evaporated has a thickness about one tenth that of the original fluid layer. The film is then stripped from the glass, labelled and its edges trimmed with scissors, before being examined optically.

A trace of some suitable dye, when added to the parent dispersion, serves to distinguish any particular batch of mounts by its tint. Rectangular films, 23 cm. × 1·5 cm. × 0·01 cm., are of convenient shape and size for microscopical examination and can be stored or posted in standard foolscap paper envelopes without further protection. With regard to the permanence of these mounts, experience has shown that they have developed no appreciable discoloration, brittleness or shrinkage after three years of storage in such envelopes.

A. T. J. DOLLAR.

as from Geology Department,
University of Glasgow.
Jan. 23.

[1] Dollar, A. T. J., *Geol. Mag.*, **78**, No. 4, 253 (1942); NATURE, **152** 248 (1943).

High-Angle Edge Flaking of Flint

MR. D. F. W. BADEN-POWELL's criterion for intentional flaking[1] is invalid, for when applied to implemental forms from Eocene deposits it gives a false answer.

Mr. J. Reid Moir's contention that series of adjacent scars form a criterion of human work fails when applied to similar series of Eocene date. My own criterion is based on observed facts and not, as Baden-Powell suggests, on an assumption that primitive man was not likely to flake at obtuse angles.

Baden-Powell states that flaking at about 90° is necessary for removing flakes from Aurignacian and Magdalenian cores. This is not a fact, for it is well known that such cores are in their final or 'reject' state. They began with an acute angle which increased as flaking proceeded to about 90°, which is the limit of easily controlled flaking. The platform is then again made acute or the core is rejected.

Primitive man adopted flaking at acute angles because it is easy, is under good control, and yields acute cutting edges. Obtuse angle flaking possesses none of these advantages.

In reply to Mr. Henry Bury[2], I would point out that natural forces were sufficiently active to leave abundant traces of crushing, abrasion and striation on the Tertiary flints.

In the series of nine human industries I gave in *l'Anthropologie*[3] from which Bury quotes, the Abbevillian, one of the oldest industries, is placed next to the Campignian, which is of Neolithic age. In the series of sixteen industries published else-

where[4], the non-correspondence between age and content of obtuse angles is clearly evident. The "Cromerian" industry was not included in my list, because recent work on the site by S. H. Warren throws grave doubts on its origin.

The Zambesi flakes are too rolled to allow of angle measurement. They are clearly of human origin and the character of the flaking is normal.

ALFRED S. BARNES.

Dormers,
Farnborough, Kent.

[1] Baden-Powell, D. F. W., NATURE, 152, 663 (1943).
[2] Bury, H., NATURE, 152, 664 (1943).
[3] Barnes, A. S., *l'Anthropologie*, 48, 221 (1938).
[4] Barnes, A. S., *Amer. Anthrop.*, 41, 110 (1939); *Bull. Soc. Prehist. Franc.*, No. 1, Fig. 6, 10 (1939).

MY letter in NATURE of December 4 raised three main issues.

(1) If, as Mr. Barnes asserts, Kentish eoliths, etc., were formed by soil movement in Tertiary times, why, I asked, did the still more active movements of the Pleistocene produce no similar results? To tell us that natural forces left "abundant traces of crushing, abrasion and striation on the Tertiary flints" in no way answers my question.

(2) Seeing that the percentage of high-angle scars rises rapidly "as we pass from the later and more skilled to the older and rougher work", I suggested that a still further rise in Pliocene times was not impossible. Barnes replies that there is no correspondence "between age and content of obtuse angles"; but, on his own figures, there is. There may be recrudescence of rough work in late industries (Campignian, etc.), with local increase in the number of obtuse angles; but no early industry shows a low number.

(3) I thought that further information about the Zambezi implements might possibly affect Barnes's conclusions. I am interested to learn that he finds them "clearly of human origin", as my impression is that some of them (not figured) are very like Kentish eoliths. That remains to be seen.

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MR. A. S. BARNES says that Mr. J. Reid Moir's "criterion of human work fails when applied to similar series of Eocene date". This is not true, at least for the Bull-head Bed at the base of the Eocene in Suffolk, which was specially investigated by Moir[1] in order to settle this question. Moir came to the conclusion that there are essential differences between fractured flints of Eocene age and those of later date described as eoliths, although occasional Eocene flints can be found which show a superficial resemblance to flints flaked intentionally.

With regard to the use of steep flaking by Palæolithic man, I agree with Barnes's criticism of a statement in my letter in NATURE of December 4 that Magdalenian flakes can be removed from the core "only" by steep flaking. Obviously some of the flakes in Upper Palæolithic work were removed at lower angles than others; but the fact remains that Magdalenian man could, and often did, remove usable flakes at high angles. I am glad that Barnes admits that these flakes are due to human and not natural agency. Quite apart, therefore, from the steep flaking used for the butt ends of Acheulean axes and for Aurignacian edge-work, it seems established that at least some high angles are also seen on various Upper Palæolithic cores. This does not invalidate the interesting suggestion in Bury's letter in NATURE of December 4 that the rise of percentage of steep flaking with antiquity may be significant; it does, however, prove that steep flaking cannot be taken as a criterion of intentional work.

D. F. W. BADEN-POWELL.

University Museum,
Oxford.
Feb. 6.

[1] Moir, J. Reid, *Proc. Prehist. Soc. East Anglia*, 1, 4, 397 (1914).

Veterinary Education in Great Britain

THE leading article in NATURE of January 8 on veterinary education provides me with an excuse for mentioning some of the obstacles I see in our path. The present is a good time for discussion; for definite decisions, it is the worst time that has occurred during my rather long life. Never has the future of the nation, or the nature of the work lying ahead of the veterinary surgeon, been so unpredictable as it is to-day.

The Ministry of Agriculture looks forward to a need for a very much greater output of veterinary surgeons —I cannot see why. No doubt, it expects to increase the numbers and the work of whole-time inspectors, but this must be largely at the expense of the part-time and independent men; and it would appear to me that the general agricultural policy pursued pre-war—as much grass as possible and bring in concentrates from abroad—was designed to support a larger head of sheep and cattle than can be kept under any other system. Ploughing up grass means fewer, not more animals.

The Council of the Royal College of Veterinary Surgeons has a curriculum committee; I do not agree with many of its conclusions, but probably that is because I am old-fashioned. I do hope we are not likely to have a curriculum rammed down our throats by Government.

The present curriculum is well designed for the production of large-animal practitioners. Besides these, we have to provide small-animal practitioners; inspectors and research men for the Ministry of Agriculture; executive and research men for the Colonial Service; Royal Army Veterinary Corps men; and a diminishing number of municipal and county officials. The qualifications needed are very different, and it will always be impossible to train our students so as to be efficient for all these purposes, on graduation.

It will be the part of wisdom if we carry on with the *status quo ante* until after the War, taking no irrevocable steps, making no changes of constitution in the colleges.

When we see the number of each different kind of graduate that will be called for, we can try to arrange a suitable curriculum, reinforced by post-graduate classes; but we can never give experience. The most important part of veterinary education will always come after appointment.

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Jan. 25.

ANNUAL MEETING OF CHINESE SCIENTIFIC SOCIETIES

A JOINT annual meeting of the Science Society, the Zoological Society, the Botanical Society, the Meteorological Society, the Mathematical Society and the Geographical Society of China was held at Pehpei, Chungking, during July 18–20 of last year. Despite the hot weather which prevailed then, 240 members attended the meeting, which was presided over by Dr. Wong Wen-hao. In his opening address, Dr. Wong said that a joint meeting like this is especially desirable in war-time, in that it is economical in time, labour and expenditure and will enhance co-operation between societies which are related in character. In view of the present tendency to overlook the study of pure science, Dr. Wong remarked that truth is what science values most, regardless of whether or not practical use can be derived from it; and he urged the pure scientists to stand firm. As a geologist and the Minister of Economic Affairs, he illustrated with first-hand examples how what appeared to be pure geology at first turned out later to be of much practical value in the detection of China's natural resources. The address of the Generalissimo was then read, in which he declares: "Pure science is the foundation of all applied sciences. If we wish to stand up among the modern great nations there must not be the slightest tardiness in the prosecution of pure science" (see also NATURE, Aug. 14, 1943, p. 180). While most of the official emphasis has been laid on the practical side in the recent tide of national industrialization, it will do the nation good to remind people of the significance of pure science.

In the business meeting held in the first afternoon, Dr. J. Needham was elected honorary member of the Science Society of China, in appreciation of his distinguished academic work and his service in promoting co-operation between Chinese and Western science, which had been so effectively carried on during the previous six months.

The six societies spent two mornings in communicating original papers dealing with their respective sciences; more than three hundred papers were read. Brief abstracts of these papers will be published shortly, in Chinese with additional English titles.

One of the two remaining afternoons was devoted to a discussion on "Science and National Reconstruction", with special reference to the problem of how science is to be promoted in China. Opinions were formulated on the following four points, which were presented to the Chinese Government for immediate adoption.

(1) The Government is requested to provide a large fund in the forthcoming national budget for, and only for, the furtherance of scientific research and of the scientific education of the masses.

(2) The personnel and equipment of the leading science institutes, such as those of Academia Sinica, must be materially augmented.

(3) The Government must endeavour to establish co-operation between the scientific workers on one hand and officials in charge of national planning on the other, so that the resulting plans may be more practical and fruitful.

(4) While the Government is considering sending a large number of young men of science abroad, it is deemed appropriate that such opportunities should be extended to mature scholars also. Here again, the Government is requested not to neglect pure science in favour of applied sciences and technology.

The last afternoon of the meeting was reserved for a discussion on "International Science Co-operation". To familiarize the audience with some idea of the subject under discussion, four specialists were asked to talk about the co-operative measures hitherto taken, along with the sound results accomplished therefrom, in agriculture, industry, meteorology, and medicine and public hygiene. Dr. Needham's address, entitled "International Science Co-operation in War and Peace", was read next by Dr. H. C. Zen, president of the Science Society of China. In this address, Dr. Needham reviewed the present position of co-operation between Chinese and Western science and the problems arising on the scientific side of the war effort of the United Nations in the Asiatic theatre; he urged, above all, that a science co-operation service should be made a regular part of the United Nations Relief and Rehabilitation Administration. The meeting was unanimous that international science co-operation, founded on international understanding and goodwill, is worthy of striving for. Indeed, Chinese men of science seek co-operation with no less enthusiasm than their friends of the West.

A scientific exhibition intended for the general public has been arranged by the learned societies of China during the present session.

DIRECTIVE AERIALS FOR RADIO COMMUNICATIONS

THE second discussion evening of the current session of the Wireless Section of the Institution of Electrical Engineers was held on January 18, when Mr. J. A. Smale introduced the subject of "Comparative Merits of Different Types of Directive Aerials for Communications". At the outset, it was made clear that the main objects of using directive aerials are to increase the field strength of the signal at the receiving station without increasing the power radiated by the transmitter, and to improve the ratio of signal to noise and interference at the receiving site; another desirable aim is to minimize interference with other users of the ether.

In long-distance communication, interest is confined mainly to wave-lengths between 13 and 100 metres; the maximum obtainable gain, in general, requires one linear horizontal dimension of some 10 wave-lengths, and, while this is realizable up to about 30 metres, it tends to impracticability at the upper end of the wave-length range. In the above range of wave-lengths, transmission is effected by one or more reflexions from the ionosphere, the characteristics of which give to the ray paths various degrees of inclination in the vertical plane. Consequently, aerials have to possess directivity in this as well as in the horizontal plane, and in some types these two directivities are dependent on one another.

The two main aerial systems used are of the broadside and linear or end-fire types. In general, the end-fire type have their horizontal and vertical directivities interdependent; the maximum concentration in the horizontal plane results in very low angles of radiation in the vertical plane, so that for short-distance circuits requiring higher angles no satisfactory compromise is possible. In the case of broad-

side arrays, individual control of directivities is valuable. A high degree of directivity in the vertical plane with broadside arrays, however, requires a height of several wave-lengths. As the wave-length increases, this height and the support of reflector as well as radiator curtains require fairly massive masts and corresponding foundations. The choice of aerials is influenced to a considerable degree by capital and maintenance costs, and availability of land, as well as by the technical considerations which lead to an overall improvement in the efficiency of the radio communication circuit.

Some of the earlier beam systems were built for very high directivity in the horizontal plane; but experience has shown that this may be overdone, since the reflecting medium is not sufficiently stable and accurate. and conditions can obtain when a transmitted beam, if too narrow, may be deflected right off the receiving aerials.

Similar structures can be used for transmission and reception, but the requirements are not necessarily the same. In general, the maximum forward gain is the chief requirement of transmitting aerials: while at the receiving station it is not so much a high signal-level that is required as a good discrimination of the signal in relation to the prevailing noise-level. During the period of maximum sunspot activity backward round-the-world echoes are troublesome, and aerials should have the maximum front-to-back ratio. Experience shows that this is more easily obtained with broadside arrays. This is true with normal broadside arrays; but even better ratios are possible if the aerial is erected off direction and electrically swung on to the forward direction; the result is that backward radiation is swung away from the great-circle bearing.

In the case of receiving aerials this applies also, but the chief requirement is the correct shape of polar reception diagram rather than gain, at least on wave-lengths greater than, say, 20 metres. With modern receivers the limiting factor above this wave-length is not input-signal level but signal-to-outside-noise ratio. In this case the power inefficiency caused by terminating resistances at the non-fed end of 'end-fire' arrays is unimportant; consequently, relatively simple and cheap aerials of the horizontal fish-bone type are adequate, take up small space, and on a given area of land can be multiplied for diversity reception. This type of aerial can be arranged for almost any degree of compromise between end-fire and broadside.

During the discussion, considerable attention was given to the rhombic aerial system, which has the advantage of retaining a reasonable directivity over a wave-length range of about two-to-one. Some of this versatility is lost when several rhombics are used in series in order to secure greater efficiency, but on the other hand greater control of the vertical radiation can be obtained, and this may be a distinct advantage in some cases.

The relative merits of horizontal and vertical polarization in the emitted radiation were discussed by one speaker, who stated that in some experiments with broadcasting transmitters, horizontal polarization had given the best results. It was agreed that a considerably wider horizontal distribution is used in broadcasting than in point-to-point communication, but not necessarily a wider diagram in the vertical plane, because the vertical angle to be covered is often of the same order in the case of communication services and broadcasting.

The chairman directed attention to the widespread interest aroused by the discussion, which showed that the subject is one of great importance to the engineer responsible either for long-distance broadcasting or point-to-point communication services.

REVISED FORMS OF THE CALENDAR

COLONEL C. A. GILL has published a small book entitled "The Reform of the Calendar—a Measure of Social Security" (Reigate: Ancient House Bookshop. Pp. 36. 1*s*.), which contains the proposals for a British Calendar. On p. 26 this Calendar is shown in full, and it agrees with the World Calendar (shown on p. 15), except that the days termed the 365th and 366th days are to be included as an eighth day in the last week of June and December respectively. It is suggested that the 365th day, June 31, should be called Mid-Year Day, and the additional day in leap years, bearing the date December 31, should be called Leap-Year Day.

A prime consideration in fixing the date of bank holidays should be the season of the year when they are most beneficial to the health of the community, and the following proposals are made, the advantages of which will be seen when it is remembered that the first day of each month commences with Sunday. A bank holiday should continue to be associated with Easter, but the date of the Eastertide holiday should have April 9 included. As Easter Sunday falls on April 8 in about 40 per cent of years, this arrangement will increase the length of the Eastertide holidays to four clear days on many years, owing to the inclusion of Good Friday. If Saturday, April 7, and Monday, April 9, were declared bank holidays, the dates of all secular events which now vary annually with the date of Easter Sunday could then take their time from the fixed bank holidays in April. It may be pointed out that April 8 is the date proposed by the World Calendar Association for Easter Sunday—a proposal which may some day materialize.

Other bank holidays which are suggested are Saturday, May 25, and Monday, May 27, irrespective of the date of Whit Sunday. Saturday, June 30, and Mid-Year Day, June 31, if declared bank holidays, would provide a three-day holiday at the end of June, Sunday, July 1, being, of course, included. The bank holiday on the first Monday in August falls on August 6 under the new scheme, and it is proposed to continue with this arrangement, Saturday, August 4, being also a bank holiday. Saturday, September 2, and Monday, September 4, would be bank holidays. As December 25 falls on a Monday, a holiday on Boxing Day with the previous Sunday and half Saturday would provide $3\frac{1}{2}$ days' holiday at Christmas.

Another revised calendar has been proposed by Lieut. Willard E. Edwards under the title "The Edwards Perpetual Calendar" (printed by the *Honolulu Star-Bulletin*, Ltd.). In this, each week begins with Monday, and anniversaries and holidays always fall on the same day of the week. Each quarter has 91 days, and New Year's Day is set apart as a holiday and is followed by Monday, January 1, thus preserving the year of 365 days and the continuity of dates each year. In the case of a leap year, the first day of the second half of the year is Leap-Year

Day, a second holiday apart from any week or month, and is followed by July 1. April 14 is the date for Easter, which is partly in accordance with the Act of Parliament in 1928, providing for the stabilization of Easter between April 8 and 15. Friday, the 13th, is completely eliminated from the Calendar, thus removing the grounds of the superstition that exists concerning this date and day. Sunday becomes the seventh day of the week, and agrees more with the Biblical Sabbath or the psychological conception of the week. All future dates can be computed without the aid of a printed calendar by remembering that the first month of each quarter always begins on Monday, the second on Wednesday, and the third on Friday, the number of days in the corresponding months being 30, 30, 31.

It is claimed that this Calendar not only introduces simplicity regarding anniversaries and holidays, but also removes many complications in the commercial world, as there are 26 working days in each month and 91 days in each quarter.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, February 19

BRITISH ASSOCIATION OF CHEMISTS (at the Café Royal, Regent Street, London, W.1), at 2.30 p.m.—Twenty-sixth Annual General Meeting.

Monday, February 21

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. B. Bailey, F.R.S.: "Natural Resources of Great Britain", 1: "Minerals". (Cantor Lectures, 1.)

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Lady Broughton: "Greenland, Mexico and Yucatan" (Kodachrome Films).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "The Use of Electricity in the Equipment and Testing of Aircraft" (to be opened by Mr. C. G. A. Woodford).

Tuesday, February 22

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. Luis Araquistáin: "Some Survivals of Ancient Iberia in Modern Spain".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. J. Ramsbottom: "Fungi and Modern Affairs", 2: "Fungi as Agents of Disease and Destruction".*

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. B. S. Bramwell: "The Order of Merit—the Holders and their Kindred".

INSTITUTION OF CIVIL ENGINEERS (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. V. A. M. Robertson: "The Engineering Evolution of London Transport".

Wednesday, February 23

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Hugh Lyon: "Education To-day and To-morrow", 5: "The Future and Functions of the Boarding School".

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. B. J. Edwards: "A Survey of the Problems of Post-War Television".

Thursday, February 24

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 2.15 p.m.—Annual General Meeting; Mr. S. W. Gibson: "The Library and Information Department of a Large Engineering Firm"; Dr. S. C. Bradford: "The Universal Decimal Classification its Origin and Purpose, Structure and Use".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Jack Drummond: "Food Fads and Food Fallacies".*

KING'S COLLEGE (in the Department of Electrical Engineering, Strand, London, W.C.2), at 3 p.m.—Mr. S. D. Thorp: "Generator Protection".*

ROYAL AERONAUTICAL SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. D. M. A. Leggett and Mr. H. Davidson: "Structural Features of German Aircraft".

BRITISH INSTITUTION OF RADIO ENGINEERS (LONDON SECTION) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Mr. C. E. Tibbs: "A Review of Wide Band Frequency Modulation Technique".

BRITISH ASSOCIATION OF CHEMISTS (ST. HELENS SECTION) (in the Lecture Room, Radiant House, Cotham Street, St. Helens), at 7.30 p.m.—Mr. H. Cole: "The Literature of Alchemy".

Friday, February 25

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. E. Rock Carling: "The Medical and Surgical Achievement of Soviet Russia in War".*

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Discussion on "Troubles, Breakdowns and their Cure".

Saturday, February 26

SCHOOL NATURE STUDY UNION (at the Central Club, Y.W.C.A., Great Russell Street, London, W.C.1), at 2.30 p.m.—Thirty-eighth Annual Conference; at 3 p.m.—Prof. W. B. R. King: "The Evidence of Fossils".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

SPEECH THERAPIST to serve the Crewe and Cheshire Education Committees jointly—The Director of Education, Education Offices, Imperial Chambers, Prince Albert Street, Crewe (February 23).

HEAD OF THE DEPARTMENT OF MECHANICAL AND AUTOMOBILE ENGINEERING, and HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING, at the Doncaster Technical College—The Chief Education Officer, Education Offices, Wood Street, Doncaster (February 24).

LABORATORY ASSISTANT IN THE DEPARTMENT OF BOTANY—The Secretary, Bedford College for Women, Springfield, Sidgwick Avenue, Cambridge (February 26).

PSYCHIATRIC SOCIAL WORKER (full-time)—The Director of Education, Education Offices, Middlesbrough (February 26).

LECTURER IN MATHEMATICS—The Registrar, Technical College, Sunderland (February 28).

SENIOR LECTURER IN MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (February 28).

WOMAN LECTURER IN THE DEPARTMENT OF EDUCATION, qualified to lecture in EDUCATIONAL HYGIENE—The Registrar, King's College, Newcastle-upon-Tyne (February 29).

ELECTRICAL ENGINEER (to instruct and supervise General Electrical Installation Work, Maintenance and Repairs), and an ELECTRICAL MAINTENANCE FOREMAN (to assist with Installation and Maintenance Work), for a Modern Iron and Steel Works in Turkey—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.755.XA) (March 1).

LECTURER (man or woman) in the DEPARTMENT OF GEOGRAPHY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (March 1).

MONTAGUE BURTON PROFESSORSHIP OF INTERNATIONAL RELATIONS—The Registrar, The University, Oxford (March 4).

ENGINEER AND MANAGER of the Walsall Gas Undertaking—The Town Clerk, The Council House, Walsall (March 6).

LECTURER IN ELECTROTECHNOLOGY in Santa Maria, Chile—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D. 763.XA) (March 8).

LECTURER (man or woman) IN BOTANY, and a DEMONSTRATOR (man or woman) in BOTANY—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (March 8).

PROFESSORSHIP OF CHEMICAL TECHNOLOGY—The Vice-Chancellor, University of Madras, Triplicane P.O., Madras' India (March 31, by cable; at the same time advise the Office of the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

DIESEL MECHANIC FOR MINING PROPERTY on the Gold Coast—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 310).

ENTOMOLOGICAL FIELD OFFICERS by the Government of Kenya Medical Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1270).

LIBRARIAN of the British Library of Political and Economic Science—The Acting Secretary, London School of Economics, The Hostel, Peterhouse, Cambridge.

WORKS MANAGER for the Sierra Leone Government Railway—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O S.30).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

The Case for the Abolition of Compulsory Mathematics in University Matriculation Examinations: a Reform of Vital National Importance. By David Brownlee. Pp. 24. (London: The Author, 56 Grange Road, W.5.) [181

National Smoke Abatement Society. Proceedings of the Eleventh Annual Conference held at the Caxton Hall, London, S.W.1, on 5th November 1943: Measures for Smoke Prevention in relation to Plans for Post-War Reconstruction. Pp. 24. (London: National Smoke Abatement Society.) 1s. [191

Employment After the War: a Memorandum submitted by the Social Credit Co-ordinating Committee for the consideration of Sir William Beveridge. Pp. 12. (Mexborough: Social Credit Co-ordinating Committee.) 3d. [201

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PLANNING AND THE MACHINERY OF GOVERNMENT

THE fundamental questions of the machinery of government and its development to serve the growing burdens which are laid upon it by the increasing integration of political and economic affairs are being repeatedly emphasized by the problems of war and reconstruction alike. These fundamental issues have been admirably stated in a report which has been issued by the Select Committee on National Expenditure. Dealing essentially with "War Production and Methods of Settling Prices for War Stores", the fourteenth report of the 1942–43 session contains a short section on the machinery of government in which the wider issues are lucidly stated. The section follows logically on an earlier report, the sixteenth of the 1941–42 session, and should be carefully considered in connexion with the reorganization of either the Civil Service or of ministerial structure and responsibility itself.

The execution of Government policy, quite apart from what has to be done in total war, or in the special conditions of post-war reconstruction, has come to be a major factor in the economic life of the country, directly or indirectly affecting every branch of its activities. This change must be taken into account in the whole organization and working of the Civil Service, including its recruitment and training, and the report refers to the earlier recommendation of the Committee regarding opportunities for bringing Civil servants into closer contact with industrial practice. Primarily, it is the impossibility of properly handling departmental activities in isolation from each other or without regard to their reactions on the general economic activity of the country that has impressed the Select Committee, through its whole series of inquiries into war production, with the need for some measure of supra-departmental supervision. Each of the Supply Departments has as its primary objective the fulfilment of its own production programme; but the national interest demands that the national programme as a whole should be kept in view, and that the delivery of the goods required for the programme should be achieved in the right proportions and with the minimum demand on manpower, materials, machinery, transport, fuel and power.

Since the Cabinet cannot be brought in at every point, the task of ensuring that departmental activities are fitted together in a coherent national effort has tended either to be neglected or to be left to committees—ministerial or interdepartmental. These have not, in the Select Committee's opinion, proved to be fully effective either in decision or in unification, and the maintenance of separate departmental responsibility has operated against unification. At the same time, the report proceeds, the tasks now assumed by Government departments are of a scope which makes it important that there should be some effective independent supervision of their execution, while their nature tends more and more to put upon Government officials tasks which should be handled with the aim of achieving constructive results rather

than merely of adhering correctly to regulations. Risks must be taken, and it is inevitable that mistakes will occasionally be made.

In regard to this aspect, too, there is no unified ministerial authority clearly charged with, and adequately staffed for, the function of reviewing the execution of Government policy as a whole. As regards Parliamentary supervision, the only properly equipped organ of Parliament exercising a function of this kind has a limited field of inquiry. The question of how to ensure the protection of the public interest in the matter of public expenditure, without adopting measures which must act as a deterrent to boldness and initiative, is one which increasingly needs attention.

The Select Committee does not outline a full plan to deal with these matters, as that would involve going far outside its terms of reference. But while it reaches the conclusion that the instruments of financial control hitherto provided by the functions of the Treasury do not meet the need for watching all the reactions of the methods employed for controlling expenditure, or for seeing that the activities of departments fit in with each other as well as with the total economic effort, it considers that the Treasury should be the authority competent to appreciate the Government position as a whole and to satisfy Parliament that the position is being kept under review. The ultimate supra-departmental authority must, of course, be the Cabinet; but the Cabinet cannot exercise the required continuous supervision and needs some instrument with which to work. The Committee suggests that for some purposes the role of the Treasury should be more widely interpreted and more constructively exercised, but beyond suggesting the appointment to the permanent Treasury staff of one or two highly qualified men to be kept free from other departmental duties, and the setting up of an advisory panel of men with practical experience in production methods and cost-accounting, including independent chartered accountants, it deliberately refrains from specifying any detailed arrangements.

These conclusions may well be compared with those reached by Political and Economic Planning in regard to the organization of foreign publicity, another field which presents some complicated departmental relations. The policy which has to be interpreted abroad may be made in a number of different departments. Vital questions to be asked in determining the form which the organization of foreign publicity should take are whether each Government department should look after its own overseas information service, and whether we should reproduce in peace-time the distinction between the British Council and whatever body discharges the relevant functions of the present Ministry of Information. Surveying the position next from the consumer end, the broadsheet takes the view, contrary to that expressed by Mr. Law in the debate in the House of Commons on the proposals for Foreign Service reform, that the number and range of specialist officials will increase, particularly in the economic field, and visualizes nutrition, agricultural and labour experts attached to the Embassy staffs, possibly with attachés concerned with the Colonies and colonial policy. In this context PEP suggests that the official concerned with information, publicity and the Press, the public relations secretary or counsellor, while directly responsible to the ambassador or minister, must look homewards through the ambassador but for a co-ordinated and coherent public relations policy and for the supply of creative material. In this matter the initiative must often come from home, however much we may stress the importance of the public relations secretary, and indeed all overseas personnel, being of the highest calibre.

Without going into further detail, it must be emphasized that news is fundamental to Government information and publicity work abroad and that it may not in practice be easy to draw a dividing line between the cultural field and political publicity. Political and Economic Planning favours the attempt to do so, entrusting the former, including the popularization of British achievement in science, medicine and agricultural and industrial technology, to the British Council, and it advances powerful arguments in favour of re-creating the Foreign Publicity Department of the Foreign Office.

In advocating that political publicity in the widest sense should be under the control of a revived Foreign Publicity Department of the Foreign Office, staffed at its higher levels by permanent members of the Foreign Service, with a good deal of autonomy, a high status, and the right to be heard before foreign policy is formulated, Political and Economic Planning makes clear the aims which such publicity should serve. After the War, that aim should be the full and fair exposition and explanation of the policy, background and cultural life of a country to the public opinion of others. Pressure propaganda and concealed methods of any kind must be strictly avoided. So conducted, Government publicity services should be a force making for better understanding and for peace, and the broadsheet also visualizes an International Information Office, the functions of which would include publicity for international political and economic agencies.

There is much in this broadsheet which is highly relevant to the discussions of a publicity service for science which have taken place in recent months, but in the present connexion its bearing on the general problem of the machinery of government is also of interest. On some specific points, recommendations for the co-ordination of departments follow suggestions which have appeared in reports of the Select Committee on National Expenditure; but on the broad issue, the line of approach adopted is that which must be applied to larger questions, as well as to particular problems such as that of publicity. Only as the functions required and the problems they present are submitted to fundamental analysis from both the consumer end and the production end can we hope to arrive at a scheme which will provide the service demanded to-day of a central government, without placing intolerable and impossible strain on those individuals from the Cabinet downwards who are required to operate the machinery devised.

The analysis of particular problems in this way enables the principles to be laid down in handling the broader and more general problem to be determined with some assurance and precision. As might be expected, this is the approach adopted by Political and Economic Planning in a subsequent broadsheet in which are formulated its proposals for a Civil general staff. In the sphere of government, we have failed to take account of the enormous development in control over material environment, particularly over communications which has characterized this century and so greatly complicated the task.

Unfortunately, a tendency for discussion on war-time controls and their retention or dispensation after the War to pass into the sphere of faction has somewhat obscured this necessity for looking into the fitness of the machinery of government for its tasks and dealing with what may be called the problem of obsolescence. Similarly, faction obscures the fact that the true safeguard against the power of an efficient administration is not a less efficient machinery of executive government, but a strong and representative House of Commons, more of the members of which are in closer touch with, and understand more clearly, the processes of administration. The one inescapable condition placed on any policy-planning organization in a democracy is that it must be purely advisory to those representatives of the people who will have to take the executive decisions.

The recent proposal of Lord Chatfield for a defence council is a particular example of the planning suggested by Political and Economic Planning to remedy the inadequacy of the pre-war machinery of government in the field of fact-finding, planning for future policy, and co-ordination and timing of policy. The problem requires tackling both within the departments and at the Cabinet level.

A major problem is to provide for the organization and co-ordination of national policies and their execution at a level intermediate between that of the Cabinet as a whole and the individual minister. The P E P solution of this problem is along the line of a group of ministers with special functions and without departmental responsibilities, and the central planning organization would conform to this pattern. Within each major department it suggests the creation of a planning group, distinct from, but in working liaison with, the various administrative divisions, and directed by a standing policy committee in close touch with the minister. There should be some flexibility according to the methods of exploring particular problems and working out policies, but the departmental planning group should always play its part.

Some inter-departmental problems could be handled by joint action between the departments and their respective planning groups, but for those of major and general importance and for the co-ordination of policies, a central planning organization will be required and should form part of the Cabinet office. As model for this the organization which has been built up for the purposes of civil administration in the War is suggested, and in general the proposals recall the recommendations of the Haldane Report, although the advisory bodies to which that report attached some importance no longer find favour. On the importance of adequate provision for the continuous acquisition of knowledge and the prosecution of research to furnish a proper basis for policy, of unimpaired ministerial responsibility and of effective Parliamentary control there is close agreement. The core of the problem really lies in those issues which cut so completely across departmental boundaries that no single department can be said to have a predominant interest.

Recognizing that the Cabinet of the pre-war pattern was far too large to be an effective instrument for shaping major issues of national policy, the broadsheet contemplates a pattern in which the Cabinet, which might be somewhat larger, is organized into two differentiated groups: first, the departmental ministers as at present and, secondly, a much smaller group of ministers without any direct responsibility for departmental administration, but directly or concurrently responsible to the House of Commons for planning in some particular field and for taking action to secure co-ordination between the departments concerned. Normally these members would form a planning committee of the Cabinet, and the broadsheet visualizes these co-ordinating ministers in the first phase after hostilities cease as organized in five groups: external relations, defence, social developments and welfare, national resources (including land) and production and distribution, which at least conform to the principle laid down by the Haldane Committee that the business of government should be distributed according to the class of service rendered.

In regard to the central planning organization, the broadsheet suggests that the present Cabinet secretariat, the Economic Section, which at present operates primarily as the staff of the Lord President's Committee of the Cabinet, and the Central Statistical Office, strengthened possibly to meet the requirements outlined in the recent memorandum by the Royal Statistical Society, would at least in broad outline satisfy the requirements of peace-time policy-planning at the centre. It stresses further, however, the value of a working liaison between the departments and universities and research institutions, and due flexibility in the use of appropriate agencies outside government in dealing with particular problems. At this point, however, we find once more that stress is laid upon the vital importance of selecting planning staff, both in the departments and in the Cabinet office, with the requisite aptitudes and techniques.

Directing attention to the temptation to self-sufficiency to which a competent Civil Service is exposed, the broadsheet stresses the dangers which follow, particularly in the scientific field. Departments are slow to mobilize in the public interest the discoveries and achievements of modern science, and unwilling to give scientific men a full share in the constructive work of government. Civil servants likewise know far too little of the relevant experience of other countries, and the broadsheet for such reasons urges that the planning group should be empowered to use freely agencies outside the Government, such

as the universities, research institutes and individuals for particular pieces of work. Such institutions and individual experts are usually free from the inhibitions which often restrict the outlook of the departments, and also command sources of information of current developments in research and ideas which are lacking in the more traditionally minded departments.

There is undoubtedly room for more interchange, in both directions, of personnel and information between the State departments and universities and similar institutions. Specialists might well be employed temporarily for particular studies, but the planning staffs should include particularly men with qualifications in, and up-to-date knowledge of, developments in the natural and social sciences, with a large proportion of temporary appointments of experts. Flexibility of mind and flexibility of personnel in the planning group are as essential as flexibility of organization, and the training to be given to the selected personnel must be not so much in the practices of the past as in the problems of the future and of the methods of attacking them.

The broadsheet reveals no disregard of the experience of the past. It draws on the concept of Combined Operations, and the suggestion that experience gained in the War may help us here in planning for peace should not be dismissed without examination. A planning staff is visualized as consisting of Civil servants carefully selected without prejudice to their future career, a few picked people from universities and research bodies on limited engagement, and specialists in a working or consultative capacity and not necessarily whole-time. Transfer of individuals from one group to another and between departmental planning groups and the Cabinet Office should be encouraged, and a working liaison between the departments and the universities and research institutions is important to facilitate this interchange of staff and particularly its disposal when any particular task is completed, whether of a group or of an individual.

That there are many difficulties in developing any such arrangements is not disguised in the broadsheet. The advantages inherent in such flexible systems are too well attested to warrant hesitation in applying them to the attack on post-war problems. What is required in the first instance is clear thinking on the functional division of ministerial responsibilities, the resolute application of an adequate policy of reorganization, and the creation of the appropriate planning organization with the proper arrangements for staffing. That must be the first step, and then only can we proceed to the recruitment of staff with the requisite aptitudes, on the quality of whom the successful functioning of our machinery of government will depend in the future as in the past. But no excellence on the part of the Civil Service, whether permanent or specially recruited for particular planning tasks, will ensure results unless the machinery is functionally and administratively sound, and stimulates initiative and vision; giving full play to the knowledge and ability and creative powers of those who use it, while retaining unimpaired the essential responsibility to Parliament.

DEDUCTIVE GENETICS

Genes and the Man

By Prof. Bentley Glass. (Science in Modern Living Series.) Pp. xii+386. (New York: Teachers College, Columbia University, 1943.) 3.50 dollars.

PROF. GLASS'S book is intended for teachers, and might form the text for a course of lectures on biology, particularly in its application to man. Its structure is definitely original. He begins with an account of the cell, including the organization of the nucleus as revealed by genetic studies, describes the segregation of genes and their functions in development, culminating in an account of human development which allows him to describe a good deal of elementary anatomy and physiology.

The notion of a gene is introduced on p. 9, and biological facts are described, so far as possible, in terms of genes. He dispenses with any serious attempt to prove the existence of genes, which are, after all, hypothetical, like atoms or electrons, from the consideration of large-scale phenomena. Yet a teacher should surely be encouraged to state the evidence for such hypotheses as genes, atoms, or radiative waves with the utmost clarity if his pupils are to understand the nature of scientific method.

However, a deductive exposition of genetics might be of great interest if it were as accurate and logically coherent as that of dynamics as usually taught. Unfortunately, Prof. Glass's exposition does not possess these virtues. He devotes no less than thirty pages to an account of mitosis, but the exposition of meiosis given, for example, in the diagram on p. 66, is incorrect, save for a few exceptional organisms such as the male Drosophila. True, the account is corrected on p. 120, but meanwhile the reader will have learned that the first meiotic division is always reductional. This is simply untrue for most genes in most organisms; and until this fact is realized much of modern genetics is utterly unintelligible. So is the mechanism of meiosis, for chiasmata have the double function of holding the bivalents together at first meiotic metaphase and allowing the interchange of genes between homologous chromosomes. It is striking that Prof. Glass describes Belar's "Die cytologischen Grundlagen der Vererbung", published in 1928, as "the most complete and best survey yet made of the cytological bases of heredity". The book certainly marked an epoch; but a very great deal has been discovered about the chromosomes since Belar's death.

Unfortunately there are a good many other inaccuracies in the book. Two of my own exploded hypotheses are put forward (fortunately without acknowledgment), namely, that the exceptional linkage in Apotettix is due to translocation, and that structural homology is a product of genic homology, though Nabours has disproved the former, and Harland the latter. We are told that more human genes have been detected in the X-chromosome than in all the rest combined. In his classical "Inherited Abnormalities of the Skin and its Appendages", Cockayne lists thirteen sex-linked genes and ninety-eight autosomal, and the proportion is fairly similar for genes affecting other organs. Blood plasma "contains salts in concentrations strikingly similar to those in sea water"; and so on.

Nor is the logic much more reliable than the facts. We are told that racial prejudice is "biologically absurd", because "it is unlikely that there are many more than six pairs of genes in which the white race

differs characteristically, in the lay sense, from the black". No believer in Negro inferiority should have much difficulty in countering this argument. One pair of genes is quite enough to make a man an idiot, and Keeler and King have produced strong, if not absolutely conclusive, evidence that the differences in tameness, brain size and other characters between wild rats and a tame strain are due to three colour genes. Scientific arguments against the congenital inferiority of Negroes must be based on facts such as those discovered by Davenport and Steggerda, rather than on deductive arguments which are scarcely more cogent than the story of the curse on Ham. Many of the other sociological deductions from biology seem to have an equally flimsy logical structure.

Nevertheless, Prof. Glass's book raises an interesting problem. Would it not be possible to write a text-book of genetics on deductive lines, like a treatise on mathematical physics? The early chapters of Fisher's "Genetical Theory of Natural Selection" represent what would be a section of such a book, and Chapter 7 of Woodger's "The Axiomatic Method in Biology" yet another, though I think that even to-day an axiomatic treatment would be premature. But such a text-book would certainly be mathematical, even if it did not use logistic symbolism. Its main value might be the revelation of gaps both in our knowledge of genetics and in its logical structure. Nevertheless the attempt would be worth making, if only because genetics is the only branch of biology which could be treated in such a way.

Prof. Glass's approach is original, and if the book were rewritten with a careful eye on errors of fact and logic, it would be of great value to teachers of biology. In its present form it contains many useful hints on the exposition of the subject, and in particular shows the central position of genetics; but the reader must be advised to exercise his critical faculty to the full. J. B. S. HALDANE.

COLOUR SENSATION IN MAN

The Fundamental Colour Sensations in Man's Colour Sense

By Gastaf F. Göthlin. (*Kungl. Svenska Vetenskapsakademiens Handlingar*, (3), 20, No. 7, 1–76.) (Stockholm: Almquist and Wiksells Boktryckeri A.-B., 1943.)

RECOGNITION of colour is a process depending upon nerve impulses reaching the cerebral cortex; hence it cannot be overlooked that interpretation of the impulses is a cerebral function. At present it is believed that nerve fibres conduct only one form of impulse and that a different fibre is required for each separate sensory factor. The retina has to initiate nerve impulses corresponding to the pattern of the external world as well as the colours of the various objects. The merit of the trichromatic theory of colour vision is that the numbers of nerve fibres are reduced to three groups, one group for each 'fundamental' colour. The 'fundamental' colour is thus the sensation produced by impulses passing up one group of nerve fibres. The theory is based on the observation that all colours can be reproduced by the combination of three separate regions of the spectrum. The simplest acceptable assumption is that there are three sets of receptors, possibly two varieties of cones and one of rods.

Prof. F. Göthlin, of Uppsala, has published a monograph on some aspects of colour recognition. Section 1 gives an outline of the history of the trichromatic theory of colour vision. As already pointed out, this postulates three 'fundamental' colours, that is, three groups of receptors which are selectively stimulated by different regions of the spectrum. These three groups of receptors must send impulses up three groups of nerve fibres to the cerebrum. Section 2 deals with the problem of yellow. Is the sensation of yellow the result of stimulating one special type of receptor with impulses passing up one group of nerve fibres, or is it the result of stimulating two sets of receptors with impulses up two groups of nerve fibres? There are several peculiarities about that region of the spectrum which gives rise to the sensation of yellow. (*a*) The range of wave-lengths which give rise to a pure yellow sensation is very narrow, and it does not correspond to the same region in all individuals. Göthlin believes that this is conclusive evidence that the sensation of yellow is not a 'fundamental' one, but it might be that the receptors in different individuals do not respond to exactly the same wave-length limits. (*b*) There is a maximum colour discrimination in the yellow region. (*c*) A yellow sensation is produced when a red light shines in one eye and a green in the other. Therefore fusion of red and green to give a yellow sensation must take place either in the external geniculate body or the cerebral cortex. The conclusion is that the sensation of yellow is a delicate balance between impulses which should give rise to red and to green respectively. Psychologically, yellow is a pure sensation, but physiologically it is not a 'fundamental' colour.

Section 3 contains a discussion of the nature of the third 'fundamental' colour, red and green being the other two. Some authorities have selected blue and others violet as the sensation produced by impulses passing up the third group of nerve fibres.

Section 4 describes experiments to test whether blue or violet is the 'fundamental' colour. Prof. Göthlin examined the thresholds for light and for colour in six individuals using indigo (425–465 mμ) as a test light. In three of these individuals the first colour to be recognized throughout the whole region was blue, and the intensity had to be raised further before the colour was called violet. Göthlin argues that the special receptors are those that correspond to a sensation of blue and that the violet sensation is due to a red element conducted up a different set of nerve fibres. He says that he does not know whether the red element is due to stimulation of special receptors adapted to respond to the short wave-length end of the spectrum, but he thinks that the impulses must pass up the same fibres as those which conduct the impulses giving rise to the sensation of red initiated by the long wave-length end of the spectrum. The simplest explanation, surely, is that the receptors for red are stimulated both by the long and short wave-lengths of the visible spectrum. The fact that two subjects saw the dissociation of indigo into blue and violet at some wave-lengths only and one did not see it at all may be due to the difficulty of the experimental procedure.

Section 5 is devoted to a discussion of the nature of the receptors in the human eye. Göthlin considers that the colour filter mechanism, which occurs in birds, reptiles and amphibia, is without significance; yet it is no more improbable than the other explanations suggested.

The curves of colour sensitivity do not necessarily correspond to the ease of stimulation of the receptors by the spectrum. Göthlin states that the possible

mechanisms are: (*a*) separate 'visual substances' with selective light absorption in their respective regions of effectivity; (*b*) a substance of general sensitivity but associated with special sensitizers for the special regions of selective activity; (*c*) a substance of general sensitivity, each receptor being adapted to its effective region by some special physical structure entailing a selective absorption of energy radiations of certain determined wave-lengths. It is not clear whether colour filters are included or excluded from alternative (*c*).

Section 6 presents a working hypothesis. This hypothesis includes the idea that certain stimuli which give rise to one coloured sensation can inhibit impulses which would give rise to the sensation of another colour. This view that inhibition may occur to prevent stimulation of retinal elements from sending impulses to produce their usual colour sensation is not new, as it has been advanced, for example, by the present reviewer[1], and it is the underlying cause of the experiments on 'rivalry'.

Prof. Göthlin presents an interesting mechanical analogy to explain the balancing of the three-colour mechanisms. There are many other interesting points discussed, but these must be found by reading the original monograph. The translation into English is excellent. H. E. ROAF.

[1] *Brit. J. Ophthal.*, *Trans. Ophthal. Soc.*, **59**, 405 (1939).

PHILOSOPHY OF ECONOMICS

The Ideal Foundations of Economic Thought

Three Essays on the Philosophy of Economics. By Dr. W. Stark. (International Library of Sociology and Social Reconstruction.) Pp. viii+219. (London: Kegan Paul and Co., Ltd., 1943.) 15*s.* net.

DR. STARK, an economist from Czechoslovakia, has included in this volume a series of critical essays in the philosophy of political economy. His attempt to throw familiar strands of doctrine into new perspective gives his work a pleasing quality of freshness. The author's interest is moral and religious as well as economic: he disapproves of the modern tendency to cut away economics from any ethical roots and, resting it on the individual divorced from his social setting, to glorify freedom at the expense of equality. His outlook is one of hostility to the positivistic tendencies of the nineteenth century. Classical political economy of Adam Smith and his successors is considered by Dr. Stark to be superior in this respect to the modern; and he uses what he deems the greater breadth and depth of the former as touchstone to the latter. "The decision between the social and ethical approach of the classical and the individualist and scientific approach of the modern economists," he concludes, "depends upon the question whether it be desirable or even possible to divide the search for the true from the quest for the good." In his view, "the vital link between them should not be severed", since "of all creatures which we know man alone has the privilege, and the duty, to raise his face toward that Infinite Perfection, in whose image he has been formed".

The book falls into three parts. The first, in many ways the most interesting, emphasizes the essential continuity between the views of Locke and of Leibniz, on the contrast between man and Nature and on the relations of man to human society, and the outlook of the classical economists. "The theories set forth by François Quesnay and Adam Smith lie, not only in the economic and social, but also in the philosophic thought of the time that preceded them; and indeed they owed more to Locke and Leibniz than to Monchrétien and Mun". It is implied that neglect of this connexion has been the ground of much subsequent misinterpretation. Dr. Stark indicates, as the key to understanding of these early writers, the fact that the unity between freedom of the individual and the good of society which they postulated rested on the assumption of an economic society of petty production by individual worker-owners. In such a society, economic freedom would include equality of opportunities, and the vesting of property-rights in labour which Locke had expounded would acquire meaning. But the rise of industrial capitalism was to bring this conception into conflict with reality. "The industrial revolution changed the outlook: the trend of development no longer pointed towards a social organization of small-scale production, based on the concord of peasants and artisans; under its influence an economic system of large-scale industry sprang up, carrying with it the discord of possessing and dispossessed".

In the second part, the author examines at some length the views of two representatives of that group of writers who had begun to appreciate that "in and through the industrial revolution the principles of liberty and equality [had become] irreconcilable": namely, Thomas Hodgskin, who criticized the inequality he saw around him but remained "an egalitarian liberal" adhering to a policy of *laisser-faire*, and William Thompson, who looked to a co-operative Utopia to supplant the existant atomistic competition. In the third part, Dr. Stark approaches a more familiar theme: the transition to the modern subjective theory of value, with its concentration on the relation between commodities and the psychology of the individual consumer. As representatives of this modern tendency he takes two less-known writers, Hermann Gossen and Richard Jennings. For Dr. Stark the essence of this transition was the disintegration of the old social philosophy and its replacement by the view that economics was a non-normative positive science; and the very deficiencies of the latter demonstrate that, if equality is to be pursued as an ideal, it can no longer in modern society be "the demand for a just division of the national wealth among all: in a society of proletarians it must be the call for the full concentration of the means of production in the hands of the community".

Dr. Stark writes with an ease and grace of style that is remarkable for one for whom English is not his mother tongue. His handling of ideas and their history shows a rare erudition and discernment. While few readers can fail to find these essays stimulating, there will be few, I think, who will not at some point be provoked to disagree. For the author's canons of criticism are individual and unusual: a quality which gives to his work much of its freshness. He is hostile to the modern tendency to analyse society in terms similar to those employed in the realm of Nature. He is hostile alike to capitalism and to the emphasis of most contemporary economic thought. But his criticism of contemporary ideas and institutions is less from a Marxist than from an idealist point of view; and as regards the method of economic inquiry, it is for a return to its ancient philosophical tradition that he pleads.

M. H. DOBB.

Basic Radio

By C. L. Boltz. (Nelson's Aeroscience Manuals.) Pp. 272. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1943.) 5*s*. net.

THIS book is one of a series of manuals covering a range of subjects suited to the needs of aeronautical students. It is of the nature of an elementary text-book, illustrated occasionally with descriptions of typical experiments, and provided at the end of each chapter with a series of exercises to test the progress of the reader's knowledge. The scope of the book is more than is indicated by the title, since no prior knowledge of electricity is assumed, and the first half of the manual describes the fundamental properties of electric currents, how these are produced, and the heating, magnetic and chemical effects that result from their use. The notion of electric charge is not utilized until Chapter 6, on condensers, is reached; and following this the nature of alternating currents is described and the manner in which these currents are affected by circuits containing inductance and capacitance. A chapter on waves describes the production of electromagnetic radiation from circuits carrying alternating currents of radio-frequency, and the main phenomena accompanying the transmission of wireless waves are dealt with very briefly. Five chapters in the later portion of the book describe the main facts concerning thermionic valves and the manner in which these are used for the generation of oscillations and for detection and amplification in wireless receivers. Other chapters deal with the use of aerials and feeders, and the methods of modulating the waves for signalling purposes.

Only the most elementary knowledge of mathematics and physics is assumed, and this can, if desired, be obtained from a perusal of other manuals in the same series. Although the subject-matter is arranged in such a way as to make this volume suitable for use as a class text-book, it will be found to be quite readable by the private student.

Clouds and Weather Phenomena

By C. J. P. Cave. Second edition, revised. Pp. viii+24+42 plates. (Cambridge: At the University Press, 1943.) 5*s*. net.

THIS little book contains a series of forty-two pictures of clouds, all beautiful examples of the photographer's art, and excellently reproduced, covering the common types of cloud. The letterpress of twenty-two pages begins with an account of the classification of clouds, including a brief but clear description of each type of cloud. There follows a discussion of the colour of the sky, sunset rays, the green ray, rainbows, haloes, coronæ, iridescent clouds, brocken spectres and mirages. The book contains a considerable amount of information of a character which is seldom to be found in books which aim at popularizing the study of meteorology, or even in more pretentious books.

The author has aimed at providing for those who depict or watch the sky, a simple account of the colours and other phenomena which they see in the sky. He has achieved his aim in a marked degree, and has packed into the few pages of letterpress much information which cannot fail to appeal to anyone who is interested in watching the sky. The book contains nothing too technical for any intelligent reader, and is one of the most satisfying books which have appeared in the field of meteorology for many years.

D. BRUNT.

Post-Graduate Lectures

Inorganic Chemistry, by Prof. H. J. Emeléus; and Organic Chemistry, by Dr. H. B. Watson. Pp. 84. (London: Oil and Colour Chemists' Association, 1943.) 10*s*.

THIS slender volume contains lectures on some interesting aspects of inorganic and organic chemistry which should be useful to those who have not kept abreast of modern work and wish to know something of its teachings. The topics are well chosen and are expounded in a clear and authoritative manner. Prof. Emeléus deals with the structure of inorganic compounds as determined by various methods, such as X-rays and electron diffraction, with crystals, silicates, radioactivity, the separation and applications of isotopes, reactions in gases and in non-aqueous solvents, and cognate subjects. The subject-matter is illustrated by clear and instructive diagrams, and many tables of useful numerical data are given.

Dr. Watson is concerned with showing how modern views on the electronic structure of atoms and molecules throw light on large groups of organic reactions; substitution, addition and isomeric change being chosen as typical. He gives references to original papers for those desiring more information. It is shown how many facts long known to organic chemists find a very lucid explanation when interpreted in the light of one or two quite simple assumptions, and thus organic chemistry is linked with general progress in theoretical physics.

Both sets of lectures are interesting, and a good deal of ground is covered in a way which should attract any reader wishing to learn something of the subjects with which they deal.

Testing Radio Sets

By J. H. Reyner. Fourth and revised edition. Pp. viii+215+10 plates. (London: Chapman and Hall, Ltd., 1943.) 15*s*. net.

THOSE who have to use radio receiving sets, whether for the reception of broadcasting or communication signals, or as an auxiliary piece of equipment in various forms of radio-frequency measurements, are likely to require for occasional reference a book dealing with radio-receiver testing and fault-finding. The present book covers the technique of this subject in a clear and simple manner, and will be found to be a useful elementary manual for the constructor as well as to the serviceman and laboratory worker. The book was first published in 1930, and the present fourth edition has received considerable revision and rearrangement in order to make it as up to date as possible under existing conditions.

Electricity and Radio Transmission

By Sir John Townsend. Pp. xi+183. (Winchester: Warren and Son, Ltd., 1943.) 8*s*. 6*d*. net.

THIS volume comprises an elementary and lucid account of the main facts of electrostatics, magnetism and current electricity, leading thence by way of electromagnetic induction to oscillatory circuits and valve amplifiers and oscillators. An understanding of all this basic knowledge is necessary to a student who is taking an interest in the science of radio-communication, although much the same ground is covered by other elementary text-books. The author's object in presenting this book is, however, to demonstrate in a non-mathematical manner the relation of the principles of radio technique to other electrical phenomena.

SCIENCE AND TECHNOLOGY IN THE NORTH-WEST OF CHINA

By Dr. JOSEPH NEEDHAM, F.R.S.
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THE previous five articles in this series[1–5], designed to acquaint the scientific workers and technologists of the English-speaking world with the present war-time work and conditions of their Chinese colleagues, dealt first with south-west China (Yunnan Province) and then with western China (Szechuan Province). We have now to report on China's great and undeveloped north-west (the provinces of Shensi* and Kansu).

A brief geographical introduction is necessary at the outset. Leaving the great Szechuan plain (Richtofen's *Rotenbecken*), itself an intermediate plateau between the high Tibetan plateaux and the low-lying plains of China east of Ichang, the traveller enters mountainous country in north Szechuan and south Shensi. Much of this is very historic ground, since it was at these passes that the warriors of the "Three Kingdoms" period attempted to maintain the independence of Szechuan. On entering Kansu province, the road goes for many hundred kilometres through the loess country, which travellers have so often described. The loess is nothing but wind-blown dust from the Gobi Desert of Mongolia to the north, but it covers and cloaks all the geological formations of the region, sometimes to a depth of hundreds of feet; and owing to its fertility and suitability for making cave dwellings, is generally thought to have provided one of the earliest homes of the Chinese people. To the north-west, the province narrows into a 'panhandle', following the line of the Silk Road of antiquity, between the snow-covered Nan Shan Mountains to the south-west which guard Tibet, and the vast wastes of the Gobi Desert to the north-east. Eventually the panhandle broadens out somewhat to meet Sinkiang (Chinese Turkestan), and here it is bordered on the south by the northern Sinised Mongolian province of Ninghsia.

The city of Lanchow itself, about which much must be said, lies on the Yellow River, at the entrance to the panhandle. Here the loess region changes to semi-desert, and the Lanchow area itself is really the first of a series of oases which runs up the panhandle and made the Old Silk Road possible; Liangchow, Ganchow, Suchow, Anhsi (formerly Guachow, the city of melons), and Tunhuang (formerly Shachow, the city of the sands). Some of these were visited by Marco Polo, at his entrance into China by the southern loop of the Silk Road (that is, round the south of the Tarim basin in Sinkiang), and he must have passed, too, through the great Han Dynasty "Gate" of China at Yümenkuan. The later Ming Dynasty one, farther in, at Djiayukuan, is still in excellent repair. Coming down into China, the modern version of the Silk Road, suitable for motor transport (and indeed from 1937 until 1940 the main channel through which assistance, from the Soviet Union, reached China in her struggle against Japan), runs into Lanchow, and then down through Shensi to Szechuan and the cities of Chêngtu and Chungking, with a loop to the city of Sian, and railhead at Baochi. This road, though in general well engineered, is subject to severe disorganization because of the nature of the country. Like the earlier main roads in the western parts of the United States, washouts are frequent and the surface is often inadequately protected against run-off water, presumably because of the lack of labour for road work. The loess country, in particular, is under constant violent erosion, and I shall never forget a day in the rainy season in southern Kansu, when the mountains seemed to be visibly dissolving, and the road was broken by a torrent of dilute brown creamy mud. The Northwestern Road Administration has done a very fine job already, but far more remains to be done before this country can be said to have been mastered.

The whole subject of transportation and communication in Chinese Central Asia is a romance in itself. On the Old Silk Road and other main arteries south of Lanchow run fleets of lorries for which the Government maintains some efficient repair and overhaul stations. These lorries all use petrol, but it may be questioned whether it would not have been preferable in the first instance to have adopted Diesel engines as a definite policy. The drivers are not as yet, of course, all very well educated; hence some strange mistakes, such as the filling up of accumulators with boiled, rather than distilled, water, presumably owing to the well-known medicinal advantages of the former. Besides the lorries, camel trains are still much employed. They operate in sections of about twenty Bactrian (two-humped) camels each; the leading animal carries the camel-driver with a white triangular flag marking the nature of the caravan, and the last animals carry bells in order to avoid their loss by theft unknown to the camel-driver ahead. A number of dogs accompany the trains to assist in protection against the wolves which at twilight abound in the winter near the Road.

As for communications, radio-telegraphy has proved of great advantage in this wild and desolate country; the remotest oases now possess hand-worked radio-transmitters, and a network of communications has thus been established throughout Central Asia. Telegrams in the Chinese ideographic language are sent according to a code, each character having its own number, and it is a remarkable sight to see the clerks transliterating their messages rarely at a loss for the right character or number, though the latter often reach five figures. The radio network forms an interesting contrast to the methods in use in the Han Dynasty (contemporary with the Romans), the beacon towers of which are met with so frequently by the traveller. Besides each ten-li fort there stand five small square conical towers, about 8 ft. in length and breadth and 10 ft. high; in this way the Han garrisons protecting the road could send to each other elaborate messages about the movements of the unsubdued tribes in the mountains to the south-west or the desert to the north-east. The positions of some of these buildings show that the fort was used as a receiving station and the five towers as transmitting stations.

One must think of Lanchow, then, as a city rather isolated at the entrance of Chinese Central Asia. It is nevertheless much modernized, and with its walls, towers and gates set in a loess valley of grand proportions beside the famous river, presents an imposing appearance. Tibetan lamas or notables and Mongolian herdsmen are to be seen in its streets, side by side with the Chinese Moslems of the province and the officials and soldiers of the Central Government. As a pioneer scientific and technological centre,

* I refer only to South Shensi, the so-called Communist area of North Shensi having been out of my itinerary, though it contains some interesting scientific institutions.

pushed out into Central Asia, it is very significant, not only now but also in its promise of future importance.

Apart from the machine shops of the truck transportation departments of the National Resources Commission and the Northwestern Road Administration, there is a large machine works jointly under the National Resources Commission and the Kansu Provincial Government, directed by Dr. Hsia An-Shin. This turns out lathes, drilling machines, shapers, centrifugal pumps, machine looms, etc., and serves the whole of China's north-west, including Sinkiang. It was interesting to see among their old machinery a 100-H.P. rolling mill for minting the copper 'cash' of former days; it is now intended to use it as a mine hoist. To stand in Dr. Hsia's foundry is to feel on the edge of some vast ocean, for there is nothing else of the kind between Lanchow and the Soviet Union two thousand miles or more to the west. The National Resources Commission also has a successful dry-cell factory and power station at Lanchow; here it was interesting to see, with Mr. Yang Chêng-Ching, insulators of all kinds of telegraphic apparatus entirely Chinese-made. Besides these industrial activities, there are flour mills, woollen mills, and a wool-washing plant, under partial Government control; and a great deal of work going on under Chinese industrial co-operatives. Some thirty branches exist in Lanchow, covering the leather, textiles, fur, paper, machine, brick and tile industries. In other cities such as Baochi, the number of such producing co-operatives may be so high as seventy. It was interesting to see, at Shuangshihpu, the Chinese Industrial Co-operatives Machine Works' pattern-shop set up in an old temple, and the wooden machine parts piled around the dusty Taoist gods. As is well known, the procedure in the Co-operatives is very democratic, and I was introduced to the chairman of the Lanchow co-operative federation, Mr. Wei Yu-Ling, an illiterate, but obviously very intelligent, textile worker, whose organizing ability has won him successive elections to this important post.

Lanchow is as important a medical as an industrial centre. It is the seat of the Northwest Epidemics Prevention Bureau's Vaccine Production Institute, analogous to that at Kunming in Yunnan, mentioned in my second article[2]. The Lanchow Institute is directed by Dr. Yang Yung-Nien, a former student of Sir Henry Dale, who worked at the National Institute for Medical Research with Dr. P. Hartley and Dr. Booth White. Apart from the usual vaccines, of which some 80 per cent go to the army, the Institute also produces diphtheria toxoid, and vaccines against cattle and sheep anthrax, and rinderpest. About eighty ponies are kept, with a special ranch for pasture feeding, and half a dozen large Arab horses captured from the Japanese. Like the Kunming Institute, the Lanchow Institute has its own glass factory. Owing to the extremely dusty nature of the country, work is almost impossible during the summer months, on account of contamination in the absence of up-to-date air-conditioning devices.

In the Pathological Department, the visitor immediately notices piles of mollusc shells on the chief's desk, and it was therefore no surprise to find that Dr. Li P'ei-Ling had been a pupil of Prof. A. E. Boycott. Dr. Li is not working at present, however, on the dextrality and sinistrality of Helicella, but rather on the position of this snail as a vector in the spread of lungworms and flukes in sheep. He is, in fact, an enthusiastic comparative pathologist. Even in this institute, the lack of materials and apparatus was depressing, although as a whole it is well-equipped with stores, considering all the conditions.

Another outstanding worker under the National Health Administration at Lanchow is Dr. Mêng Mu-Ti, one of China's best pharmaceutical chemists, and a former colleague of Prof. J. H. Burn. He is now engaged in starting a Government pharmaceutical factory, and work is proceeding on the making of petroleum jelly from the residues from the oilfield, mentioned below; saponins from soap beans, pure salts and borax from Chinghai (Lake Kokonor) bitterns, potassium permanganate from pyrolusite, ephedrine from *ma huang*, eumenol from *tang kuei*, etc. In this connexion, the following contrast is of interest. Everyone has read of the use of butter by the Tibetan lamas in their monasteries for modelling coloured pictures, burning in shrine lamps, etc. Recently the Chinese Air Force has established a casein factory at the famous lamasery of Labrang (Hsiaho, not very far from Lanchow), so that the butter now goes to a more technical, if less traditional, use. From the whey, lactose is prepared by Dr. Mêng Mu-ti's laboratory workers.

In medical education, Lanchow is also important. The National Health Administration's Personnel Training Institute, presided over by Dr. Li Wên-Ming, produces dispensers, sanitary inspectors and 'nursing assistants'—these latter may be regarded as analogous to the old Russian grade of 'feldshers' in remote country places, who were not medically qualified, but had sufficient medical education to run rural clinics 'of first appeal' and attend to public health. A somewhat superior grade of such men is being turned out experimentally by the Northwestern Junior Medical School, also in Lanchow, under Dr. Chi Ching-Hsing; here medical men are to be trained in four years instead of six, with a 'rural' instead of a regular qualification diploma. The emphasis is on practical rather than theoretical knowledge. It remains to be seen how successful this will be, but the Chinese certainly have an enormous problem in introducing modern medicine into Central Asia, and in the opening stages a system such as this may be very beneficial. Besides the above, Dr. Li Wên-Ming's Institute also organizes refresher courses for medical men, nurses, public health officials, and the groups originally trained there. Dr. Chi has on his staff the brilliant Edinburgh surgeon, Chang Cha-Li, whose work at the National Health Administration's Northwestern Hospital is very noteworthy. It was at this hospital that I noticed a little touch exemplifying the Chinese genius for improvization—on a table outside the clinical laboratory door, an egg-shell was lying; but it had a label attached to it, and on closer inspection proved to contain a pathological specimen. In the shortage of glass tubes, what more suitable sterile container could be found. Lanchow has another excellent hospital and leper colony under Dr. S. Hoyte of the China Inland Mission.

Among the most interesting of Lanchow's institutions is the Kansu Science Education Institute. This organization, a group of Chinese-style buildings in a beautiful garden just outside the city, was started with British Boxer Indemnity Funds in 1936. Successive directors were Profs. J. B. Tayler and Y. P. Mei of Yenching University; the present head is Dr. Yuan Han-Ching, a specialist in stereochemistry from Roger Adams' laboratory at the University of Illinois. It was intended to be a research institute as

well as a focus of Central Asiatic popular education in science, but under present conditions very little research can be undertaken. There is, however, work proceeding on the ecology and entomology of the Nan Shan Mountains, and the institute has a useful library. Particularly active are the workshops, under Mr. Hsieh Yu-Shou, making scientific apparatus for the schools of the province. This resembles that produced near Chêngtu (and referred to in the fourth article of this series[4]); tuning-forks and pulleys are made of salvaged aluminium from shot-down Japanese aeroplanes, and weights for chemical balances from melted bronze coins of former dynasties. About a hundred complete sets of eighty pieces of apparatus each are produced each year. The section of geology and mineralogy, moreover, produces boxed sets of ore and rock specimens, as well as wooden stratigraphic models, which were pronounced by a geological friend who accompanied me as better than those he had seen in many Western universities. Then the popular science education division under Mr. Chêng An-Lun is also active, and some of its work is to be seen in the large illustrated wall-newspaper, changed once every ten days, and set up at the city's civic centre. During my stay in Lanchow, I noted interesting articles on Archimedes and the history of geometry, on twinning and other questions in experimental morphology, and on parasitic insects.

The Chinese Industrial Co-operatives also have a research institute in Lanchow; it has a good library, and carries out work on leather technology, wool textiles, etc.

Coming now to more formal technical and scientific training, though no university exists in Lanchow, there are a number of institutions worth notice, since here in Central Asia, learners are truly in the 'front line' of science and technology. First, there is a Teachers' Training College, the largest of its kind in China, under Dr. Li Chêng, which includes scientific instruction; and then there is a Polytechnic College (similar to that at Chiating described in the fourth of this series of articles[4]) under Dr. Tsêng Chi-Kuan, specializing in animal husbandry, agronomy, irrigation, etc. Of particular interest are the Technical Training Schools of the Chinese Industrial Co-operatives, which exist at Shuangshihpu and Chêngtu, as well as at Lanchow. Here many child workers of promising intelligence are given a good all-round as well as technical education. At Lanchow one can see boys of sixteen or so acquiring an insight into all the mysteries of the textile industry, or a couple of Tibetan-Chinese youths newly arrived from the back country at work on the solid geometry of the screw-thread. The Co-operatives' schools, which act also as centres of local culture, keeping alive such things as the folk-songs of the people, are named Baillie Schools, after Joseph Baillie, an ex-missionary who devoted his life to the cause of technical education in China.

Before leaving the city of Lanchow, a few words may be devoted to some of the American technical experts who have made it for a time their headquarters. Dr. Theodore F. Dykstra, whom we have mentioned before, has been at work on a widely extended survey of potato culture across the length and breadth of Free China. There can be no doubt that his efforts will help greatly in the freeing of the Chinese potato crop from the curse of virus diseases of all kinds with which it has so far been infested. Dr. W. G. Lowdermilk, an internationally known erosion and soil-conservation expert, with a group of Chinese colleagues, such as Dr. Stephen Fêng, has also gone up and down the country, and they will be making important recommendations for the better conservation of the north-west, and the fight against desiccation. In this connexion, mention should be made of Kansu's exceptionally enlightened Commissioner of Reconstruction, Mr. Chang Hsing-I; according to him, Kansu's greatest problems are the more successful location of subterranean water along the Silk Road, and the full exploitation of the oil throughout the province.

Much has been written on the progressive desiccation of north-western China. I have myself observed in far North-west Kansu that the foothills of the Nan Shan, which are described on Sir Aurel Stein's maps of 1905 as "covered with thick brushwood", are now completely desert, with only the thinnest scrub in the dry watercourses. In Northern Suiyuan (another Sinized Mongolian province) the *pailous* (commemorative arches) of not very far-distant date are now buried in sand up to a foot or two of the top. It is not clear, however, that this process could not be stopped by modern methods of afforestation, soil conservation and irrigation carried on over a sufficiently long period by a sufficiently determined Government. The richness of the oases (for example, Gaoṭai, on the Silk Road in Kansu) and the well-deserved fame of the melons of Hami and Tunhuang, suggest that given irrigation, almost anything will grow on the sandy soil. It would seem that the main need for the north-west is the introduction on an enormous scale of modern agricultural methods. For example, on the rolling loess highlands between Tienshui and Lanchow, especially south of Huadjialing, the whole area could be put under fruit-trees, taking advantage of the lower southern slopes. Given then improved transportation facilities and a canning industry to take care of fruit surpluses, the area could become of great importance for the improvement of the national diet. Szechuan, again, perhaps the original home of the orange, suffers to-day from periodic gluts, which, if cold-storage plants and means of making ascorbic acid concentrates were available, could readily abolish vitamin C deficiency in large parts of China.

Animal husbandry, too, has great importance for Chinese Central Asia. The pastoral culture of many of the tribal peoples such as Mongols and Qazaqs was, and is, based on it, but Tibetans and Chinese also have many flocks and herds. Government sheep-improvement ranches are maintained at Minhsien and Yungchang in Kansu. Both the U.S.S.R. and New Zealand, at the request of Dr. Ku Chien-Chi (now scientific adviser to the Sinkiang Government, then of the Kansu agricultural service) have sent sheep to improve local stocks, and artificial insemination is now being undertaken. The 150 New Zealand sheep of various breeds are still, however, undergoing an odyssey; destined in the first place for the Burma Road via Rangoon, that city fell before they arrived, so they were sent to Calcutta instead; then after an ineffectual attempt to get them in through Assam, they were driven up to Lhassa in Tibet, and at present are somewhere on the road between Lhassa and Lanchow.

Besides the vaccine production institute already mentioned, there is another for veterinary sera at Lanchow, directed by Dr. Frank Liu under the Ministry of Agriculture. Since no refrigeration plant is available, the products are stored underground with ice from the Yellow River, which often freezes over in winter.

The reader must now imagine himself transported away up the Silk Road to a location in Central Asia which cannot be named or identified for security reasons, namely, the oilfield which to-day supplies the greater part of the petrol used by the Chinese. On the way, he will have passed for many miles along the Great Wall, and will have observed the triangulation tripods of the Chinese Geological Survey on some of the towers. At the oilfield, men from the Royal School of Mines (of South Kensington) are prominent; such as Dr. Shao I-Chou, who capably seconds Dr. Sun Yu-Chi as manager, and the oil geodesist, Dr. Ong Wên-Po. The field is one of the highest in the world, lying among the largely unexplored ranges of the Chilien Shan, and the issuing oil is probably the coldest, thus giving rise to special difficulties not met with elsewhere. The refinery, under the oil chemist, Dr. Chin Kai-Ying, produces all grades of petrol and light oils, waxes and greases. It seems clear that the field is a good deal larger than had hitherto been believed, and should be a highly important factor in post-war Chinese industrial prosperity. Nor does it stand alone, for seepages of oil occur all down through the Province of Kansu. They have been known to the peasants probably since remote antiquity, and have been used by them for greasing axles of country carts as well as medicinally; they account undoubtedly for mentions of oil by Marco Polo and for the accounts of "weak water" in other ancient and medieval writings.

Finally, the reader will remember that this region is one of the classical areas of the whole world for archæological exploration. The discoveries of Stein, von Lecoq and Hedin were possible largely because the desert climate preserves all sorts of antiquity in the most perfect way. One has only to dig in the rubbish-heap beside some deserted Han fort to find shards of Han basins, cloth belt of the Tang, a rope-end of the Sung, and broken pottery of all periods. So also the painted plaster surfaces of Lamaist stupa-tombs last in the open air surprisingly for centuries. Some fifteen miles south of Tunhuang, on the Kansu-Sinkiang border, lies the historic site of Chienfotung ("Thousand-Buddha Caves"). Here, for a distance of some two miles along the dry river-bed, the metamorphosed gravel cliff is honeycombed with caves, ranging in size from a suitcase to a cathedral and partially protected from the weather by a small, well-irrigated, and charming oasis.

The walls and ceilings of the caves are covered with well-preserved fresco paintings of all periods from early Wei through Sui, Tang, and Sung to Yuan (A.D. 380–1360), mostly of the earlier periods, illustrating the daily life of the people as well as the rites and ceremonies of the various forms of the Buddhist religion. They constitute, indeed, owing to the perishable nature of traditional Chinese architecture which used wood rather than stone, the greatest natural museum of art and archæology which China possesses. In one of these caves it was that Stein discovered long ago the famous hoard of Tibetan, Manichaean, Sogdian, Sanskrit, and Chinese books, much of which is to-day in the British Museum. In the oasis there is now a Tunhuang Research Station under the Ministry of Education; but unfortunately, in war-time, little has been done to preserve the caves, the painted plaster walls and statues in which do show a certain tendency to break away and spoil. It is a remarkable comment on Chinese traditions of scholarship, however, that in the middle of a war such as the present, their Central Press Agency should maintain at the caves a group engaged on a systematic photographic survey of the frescoes. This site will certainly in the future be the scene of further great discoveries of Chinese archæology.

[1] NATURE, 152, 9 (July 3, 1943).
[2] NATURE, 152, 36 (July 10, 1943).
[3] NATURE, 152, 64 (July 17, 1943).
[4] NATURE, 152, 343 (Sept. 25, 1943).
[5] NATURE, 152, 372 (Oct. 2, 1943).

PHOTOGRAPHIC PHOTOMETRY

A SYMPOSIUM on "Microdensitometry and Microsensitometry" was held at the Royal Photographic Society's House in London on January 29. It was attended by members of the Royal Photographic Society and of the Association for Scientific Photography. There were four speakers: Dr. G. B. Harrison of the Research Laboratories of Ilford Limited; Dr. A. Hunter of the Royal Observatory, Greenwich; Mr. A. R. Stokes of the Crystallographic Laboratory, Cambridge; and Mr. D. M. Smith of the British Non-Ferrous Metals Research Association. Dr. H. Baines, vice-president of the Royal Photographic Society, was in the chair.

After formal opening of the proceedings by the chairman, the subject was introduced by Dr. Harrison. He said that his task was to remind the audience of the more important factors which have to be borne in mind in accurate photographic photometry, particularly microphotometry. After pointing out that photographic materials, being sensitive to light, lend themselves to the comparison of light intensities, he said he wished to emphasize the fact that the use of photographic materials for such purposes is not without pitfalls for the unwary. Photographic photometry is based on the assumption that if two exposures are made on two different regions of the same photographic material, and these exposures are equal in all respects, then the densities produced by the two exposures will be equal. By exposure is meant the total amount of light received, which is the illumination multiplied by the time of exposure. It will be recognized that this assumption is only true under certain conditions, and a thorough knowledge of these limiting conditions is necessary to avoid the pitfalls and to pick one's way skilfully between them.

In practice, the magnitude of the test exposure to be measured will not be known, and it is necessary to record on the photographic material a range of exposures so that a curve relating some function of the exposure to the density produced can be drawn. It is in the application of this series of exposures that lies the key to accurate photographic photometry.

Dr. Harrison then reminded the audience of the requirements, which he said must not be regarded as placed in order of importance, because this depends on the conditions of the work in hand. The calibrating exposures should be similar in size, shape and surroundings to the test area. This arose because the density developed in any given area of material may be influenced by the density being developed in an adjacent area. The fact that the sensitivity varies with wave-length of radiation is so well known that it is obvious that the calibrating source should have the same spectral emission as the test source. Although the photographic material records the total amount of light, it is not indifferent to the way in which it is received. A high intensity for a short time does not give the same density as a low intensity for a long

time, even though the total light received be the same. An exposure broken up into several shorter exposures may not give the same density as a continuous exposure of the same total light value. It is therefore necessary to ensure that the calibrating exposures have the same distribution in time as the test exposures, the intensity only being varied. The test and calibrating exposures should be separated by as short an interval of time as convenient, and if the interval has to be appreciable, a relatively long time should lapse before development. This precaution is occasioned by the possibility of changes in latent image after exposure and before development.

Having thus applied the calibration exposures, it is necessary to secure as uniform development as possible, and to measure all densities on the same densitometer. The particular type of densitometer used is of little importance provided it is capable of giving reproducible results.

Dr. Harrison said he had laid down briefly certain ideals to aim at, and he fully realized that it seemed a discouraging prospect, particularly as the practical conditions of the work frequently preclude the possibility of satisfying all the points enumerated. It is in these circumstances, however, that a full knowledge of the limitations of the photographic process is so valuable in enabling the user to judge, or better still determine, the penalty he will have to pay, if any, for neglecting any of the fundamental requirements. In fact, the art of photographic photometry may be said to lie, not so much in the ability to satisfy all requirements, as in the ability to minimize the consequences of the inability to satisfy all.

Dr. Hunter then followed with an interesting paper on the use of microphotometry in astronomy. He said that photography is probably the astronomer's best friend because it is capable of recording total light and can integrate that light over long periods of time, and because it provides a permanent record. It is surprising how much useful information is obtained as a result of a re-examination of old plates in the light of new discoveries. The main use of photographic photometry is in the measurement of stellar magnitudes, and in the recording and measurement of stellar spectra. The latter give valuable information on temperature, and the Stark and Doppler effects yield data on mass and velocity respectively. The wave-length range concerned usually lies between 3,000 and 10,000A., though astronomers are generally rather suspicious of the behaviour of photographic materials at very long wave-lengths. To give some idea of the light intensities involved, he said that a first magnitude star provides an illumination of about one millionth of a metre-candle, and although the telescope might increase this by about a thousand-fold, it is still a very low level of illumination. When spectra are being recorded, it is, of course, lower still.

Referring to the requirements enumerated by Dr. Harrison, he said that frequently they cannot all be satisfied. For example, if the star image be formed on the slit of a spectrograph, the varying refraction of the atmosphere causes the image to move about, and in any event since the image is necessarily small, it is often artificially moved up and down the slit during the exposure to increase the effective height of the recorded spectrum. The exposure is therefore intermittent, though the calibrating exposure is normally continuous.

Perhaps a more flagrant breach of the conditions occurs when the calibrating exposure time differs from the test exposure time. Exposures are sometimes necessarily lengthy, and it is inconvenient to make the calibrating exposures of the same length. It is recognized that this procedure may lead to errors, and Dr. Hunter recalled an investigation he had made to determine the magnitude of the effect in relation to a series of experiments he was making. The calibrating exposures were made with an exposure time of 20 sec. and the test exposures varied from 20 sec. to more than 500 sec. The error was found to be appreciable and to vary with the type of plate used. He was able to obtain a relationship between observed and true stellar magnitude, so that a correction could be applied according to the test exposure time.

Dr. Hunter then discussed the question of the microdensitometer. He pointed out that most instruments give a record of the variation of transmission against position on the plate. What is really required is the curve of density against position, which can only be obtained by laboriously going over the transmission curve, taking the logarithm of the reciprocal of the transmission, and replotting. He showed diagrammatically the principle of a recording microdensitometer developed in Holland just before the War, which consisted in an addition to be fitted to any existing densitometer. The Dutch succeeded with this instrument in making a new atlas of the sun's spectrum which is already yielding valuable results. The chief drawback to this instrument is that a template has to be placed in part of the optical system of the subsidiary unit, and the shape of the template depends on the characteristics of the photographic material at the wave-length being measured.

In the United States a much more elaborate instrument has been built which overcomes this difficulty. The test spectrum and calibrating plate are both placed in position on the table of the instrument and the preparation of the density record is fully automatic. The instrument is said to be accurate, and a slide was shown of duplicate traces showing extremely good reproducibility.

The meeting was next addressed by Mr. Stokes, who commenced by briefly describing the fundamentals of X-ray crystallography with special reference to the Debye-Scherrer method. The specimen, consisting of a single (rocking) crystal or a 'powder', is placed at the centre of a circular camera carrying a strip of film located on the circumference of a circle with the specimen at the centre. A narrow pencil of X-rays as nearly monochromatic as possible is incident on the specimen, and the emergent beam is trapped to avoid scattered radiation in the camera. The lines in the spectrum are reflected at different angles depending on the lattice structure of the crystal material and the wave-length of the incident radiation. The wave-length range with which the crystallographer is concerned is 0·5–2·5A. The width of the lines obtained depends on several factors, among which is the perfection of the crystal lattice itself. The line width is usually of the order 0·5 mm. on the film.

With reference to the requirements laid down by Dr. Harrison, Mr. Stokes said that the crystallographer is probably in a privileged position in that the photographic material does not exhibit reciprocity failure when exposed to X-rays. It is therefore possible to make the calibrating exposures by means of a time scale, for which a sector wheel giving exposures increasing in arithmetical progression is

used. From density measurements on these regions a curve relating density to exposure can be drawn. This usually yields a straight line up to a density of about 1·5.

Mr. Stokes raised the important question of the effect of the size of the slit of the microdensitometer. The error introduced can be corrected by formula. In this connexion figures were given for the variation of observed density due to the graininess of the photographic material. The variations are appreciable, and it was pointed out that the height of the densitometer slit is limited by the fact that the spectral lines are curved, particularly at large angles of reflexion.

Another interesting point concerns the difference between the appearance of the X-ray spectrum and the recorded trace. A slide was shown illustrating a series of spectral lines and the corresponding density trace. The appearance of one of the lines suggested that there were two lines close together, one being much denser than the other. The densitometer trace revealed that the less dense 'line' was no more than a barely significant shoulder on the record of the line. The second peak was, in fact, not a peak at all, but merely an indication of the existence of a point of inflexion in the density trace. The slide showed the method of taking account of the fog or background which is nearly always present and usually increases towards the position of zero deflexion of the incident beam. It is usually possible on the density trace to draw a smooth line passing through the minimum density positions.

The use of photographic photometry in quantitative spectrum analysis was dealt with by Mr. Smith. The spark spectra of metals or alloys containing small quantities of impurities are recorded photographically, the most important region being in the ultraviolet from about 2,300A. to 4,500A. Spectrum analysis is most useful when the impurities are present in amounts less than about 2 per cent. The principle of the method is that the intensity of an impurity line is related to the intensity of a basis metal line according to the percentage impurity present. The procedure is to prepare a series of standards containing known quantities of impurity, and, by comparing the relative densities of basis metal and impurity lines, to determine the percentage corresponding with the relative densities obtained from the test sample.

Accurate calibration of the plate presents difficulties peculiar to the problem. Since a light source similar in constitution to the test source is required, a spark source is indicated; but unfortunately this is variable in both intensity and in the relative intensities of the different lines. The simplest and probably the most accurate method is to photograph a range of standards samples on each plate; but this has the disadvantage that it leaves less room for test exposures, it rapidly consumes carefully prepared and analysed standards and it appreciably increases the time taken. Another method is to use a rotating stepped sector in front of the slit. This method yields an intermittent calibrating exposure, but it has been claimed that this is permissible provided the sector disk is rotated at a rate of 200–300 r.p.m. The intermittency effect can be overcome by using a stepped density wedge in place of the sector shutter, but this has been little used owing to the difficulty of obtaining satisfactory densities which are neutral over the requisite wave-length range.

Mr. Smith believes that the chief sources of error lie in the inconsistency of the light source, and that errors in the photographic process play a relatively unimportant part. He hopes that the reproducibility of the source will be improved in the near future.

Some discussion took place after the papers in which questions of detail were asked. Mr. L. V. Chilton agreed that photographic photometry has its difficulties and that a complete understanding of the principles involved is essential to success. On the other hand, microphotometry has its own particular difficulties, and though some of the speakers had indeed dealt with certain aspects, there are many interesting points peculiar to this field which could profitably be discussed in detail.

THE FOREST AS A FACTORY

By Prof. E. P. STEBBING
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IN a memorandum written for a Government conference last summer, I made the statement that the forest is a "factory" just as much as a factory turning out tanks or aeroplanes. The statement appeared to create some surprise. Let us consider how it may be justified though, with the exception of India, inadequately recognized in that great organization the British Empire and Commonwealth of Nations.

We will first look at India; in spite of the fact that many heads of the other forest services hold that Indian forestry conditions, with all their great range of climate, soils, species, plains and mountains, are not applicable to conditions outside that country. During the War of 1914–18, India very soon found herself, owing to deficient shipping, deprived of many imported goods and left to her own resources. The forests, with an adequate forest staff for the purpose, were soon called upon to supply large military and civil requirements; and the young Forest Research Institute played a remarkable part in assisting in this matter. This is familiar history. Once again, in the present War, the same position has had to be faced in India on an even larger scale. Once again her forests, having been under a conservative management for just eighty years, under an adequate forest staff and assisted by one of the biggest and best equipped forest research institutes in the world, have proved adequate to the call upon their resources.

An examination of some of the War publications from the latter, *Records*, *Bulletins* and *Leaflets*, prove, if proof be necessary, that the forest is merely a giant factory which in combination with the work of the research officer (for example, in an aircraft factory where the combination is now fully recognized) can face new demands, provided a sufficiency of labour is available. Examples of this work have already been given in these columns (NATURE, **153**, 201; 1944). They furnish evidence of how research, with the forest to provide the necessary raw materials, was able to come to the assistance of the Fighting Services, as well as civilians, when imports of many kinds ceased. The research part of the 'factory' solved the problem of finding a substitute article for the one which could no longer be imported; the 'forest factory', according to location of supplies, well known to an organized department, provides the raw material; and the third 'factory' in the business, the only one recognized by so many, makes up the article. But the third would have been non-existent

had not the second existed. A prerequisite to all this organization and its successful issue, without over-exploiting or devastating the national forests, the ownership of which is—or should be—vested in the peoples of the country, depends upon an adequate forest staff, and a working knowledge by the latter of the whole of the forest areas of the country concerned.

A study of recent annual reports of some of the Colonial Forest Services is by no means so reassuring. In many instances the 'forest factory' is being heavily exploited for war requirements without the requisite safeguards, which are adequate knowledge of the contents of the forests and a sufficient staff to superintend excessive fellings. The capital of the country, which belongs to the people of the country, is consequently being dissipated.

Reference has already been made to the heavy unsupervised fellings being made in the United States in the Douglas fir and companion species, West Coast hemlock, Sitka spruce and Western cedar forests to supply war-time demands (NATURE, 152, 651; 1943). Another instance of the same is quoted from Alaska. In the rain-drenched Tongass National Forest of the unknown south-eastern Alaskan panhandle, a forest larger than the State of Western Virginia, is situated what is said to be the world's last great reserve of Sitka spruce, the pre-eminent aircraft timber. Many thousands of these great trees, with a height of 200 ft., 80 ft. clean bole to first branch and 6 ft. diameter at breast height, were felled in 1943; the War Production Board, with much of the best forests in Oregon, Washington and British Columbia cut over, having arranged to open out the Alaskan wilderness.

Many examples from recent publications could be culled to show the position the forest occupies in a country in periods of stress when that country can no longer rely on imports of certain staple commodities. The forest at once forms one side of the 'factory'. Without the forest several types of factory, including one of the latest, the plywood factory, would not exist. No commercial man would consider it possible to run a factory in peace- or war-time without the necessary trained supervisory staff to ensure efficient output and a continuity in that output. Any attempts to reduce such staff as redundant would be met with suspicion and a *non possumus*. Further, it would be equally recognized that to ensure that a continuity of output is maintained supplies of the necessary raw materials must be available in the amounts already calculated.

How does the 'forest factory' come off in this respect? A study of even the few instances given above serves to show that the position of the forest as regards the supplies it affords to the factory dependent upon it and its relation to that factory is rarely understood. The idea appears to be still held in some quarters that the forest can go on supplying indefinitely the products required from it with a very inadequate supervisory staff, if indeed any such staff is present; whereas the truth is that this type of utilization of the forest results (far quicker in war-time) in its gradual exhaustion, and with the latter the collapse of industries and their man-power dependent upon them. For a forest is a delicate organism and easily ruined by ill-judged fellings.

How is the forest to be maintained and safeguarded? To rehabilitate a forest which has been wastefully and ignorantly exploited, in the absence of expert supervision controlling the work, will take a century or more, if timber is the desideratum. How is a continuity of material from the forest and the consequent continuity of the factories dependent upon it to be maintained? A trained and expert staff is necessary for the factory. Equally so for the forest. If, as so often in the past in the British Empire, such a staff is only brought in in inadequate numbers, after the forests in question have been partially or totally ruined by over-exploitation in one or other of its many possible forms, a long and uphill struggle has to be faced and considerable expense. Trees are not agricultural crops; they require considerable periods of time to produce what is required; even if only of small size such as pitwood, fuel plantations and so forth. In the absence of a trained staff, an ignorantly exploited forest, if of conifers, may result in the total disappearance of the forest from the area; if of hardwoods, the same may take place, the time elapsing being much longer. But the final results in many cases may be the disappearance of the population which lived in that neighbourhood. History has already witnessed whole populations moving to more salubrious parts or gradually dying out owing to the destruction of the neighbouring forests, with the consequent impoverishment of the soils and the diminution of the water supplies. In former times the aftermath of forest destruction and impoverishment of the soils only made its appearance over long periods of time; not so nowadays. With increased populations, with increased methods of rapidly exploiting rich forest areas, and greatly improved methods of transport, a forest can be destroyed, so far as its future usefulness to man is concerned, in a comparatively short time, even in days of peace.

In times of war and stress, an accessible forest and, with expense no object, previously so-termed inaccessible forests, unless under the watchful supervision of their only possible guardians, the trained forest officers, fully acquainted with their regions and in sufficient numbers to enforce correct methods of working, can be exploited and ruined in a very short space, as in the American examples quoted above.

In connexion with the improvident and ignorant utilization of the forest by the populations inhabiting the regions in the past, alluded to above, the present-day consideration being paid to soil conservation schemes both in parts of the Old World and the New merits mention here. Perhaps the most modern examples of the ignorant treatment of forest and agricultural soils is to be seen in the popularly termed 'desert bowls' in the United States and parts of Canada; and also in Australia. As a result, thousands of farmer families have had to emigrate, the once fertile regions having been reduced to desert conditions. But the world has had for long many older examples, and over wider regions, of this misuse of the land and its vegetation. The British Empire affords many illustrations, of which large stretches in Africa offer examples. This position is at length being considered from the only possible practical aspect, to wit, soil conservation schemes—schemes the primary objective of which is to stay the further desiccation and spread of desert conditions, coupled, as they invariably have been, with lessening rainfall and water supplies and the migration of the peoples affected.

Excellent examples of the modern changed attitude to this question are afforded by the Governments of the Sudan and Kenya. These Governments have apparently realized that soil conservation must be

approached by bold schemes, not by small experiments of merely local interest having little reference to the broad requirements of the country affected as a whole. In the Sudan, an active soil conservation policy is under consideration. The sitting committee has adopted, it is understood, a comprehensive programme for which a considerable sum has been earmarked, and which, if and when put into force, will immediately provide employment for a portion of the demobilized native troops. In Kenya, projects of development are foreshadowed. The principal scheme is one for soil conservation, for which it is said a sum of £940,185 has been allocated.

The forester will indubitably take an active part in this work; for trained supervision will be essential if money is not to be wasted. One of the forester's jobs will be an endeavour to replace blocks of forest on the ruined and impoverished soils, the primary purpose of which will admittedly be a protective one while assisting in the restoration of the soil water supplies. But as the secondary objective, these forests will in time serve as the factory from which produce will be available to an increasing population returning to a formerly destroyed but now rejuvenated area.

These are neither visions nor dreams. But to understand the job and its possibilities, it will be at least necessary to allow those whose business in life it has been to study, consider, and interpret the factors concerned, to prescribe the possible practical remedial measures to be put into force and, in addition to the necessary funds, to ensure that a trained staff in the necessary numbers is forthcoming.

PRENATAL MORTALITY AND THE BIRTH-RATE

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MAXIMUM reproductivity in a monogamous society requires that males and females of appropriate age shall be available in approximately equal numbers. A considerable excess of one sex or the other will decrease the reproduction-rate. In practice, there rarely seems to be an excess of males of this age; among European races a slight excess of females is usual. War, or other events involving a differential toll of men of reproductive age, naturally exaggerate the excess of females. In England and Wales before the War of 1914–18[1], there was an excess of some 649,000 or 8·7 per cent of females over males, at ages 20–45 years. For several years after 1918 the excess was more than a million, being about 1,050,000, or 13·4 per cent in 1925[2]. Ten years later, in 1935[3], the effects of the war were disappearing and the excess of females was down to 658,000, or 7·9 per cent, but it may well increase again considerably as a result of the present War. The surplus women, on statistical grounds alone, are evidently unable to get married in Great Britain, and the great majority of them, therefore, are sociologically sterilized. The number represents an appreciable percentage of the females of reproductive age, and this sociological sterility is a not inconsiderable factor in birth-rate problems. Groome[4] calculated that an increase in the net reproduction-rate of some 15 per cent would be expected to result from equalizing the numbers of males and females of reproductive age, even without any increase in the total population.

The only immediate solution of this problem of sociological sterility, whether due on a smaller scale to natural causes or on a larger scale to war, lies in a fundamental change in our social conventions. There are, however, other possibilities for a longer term policy. The excess of females is not found at all ages. In England and Wales, about 104 males are born to every 100 females. According to Russell[5] the mean ratio for 1838–1933 was 104·3, the range of yearly variation being about 103–106. The highest ratio was recorded in 1919, and this apparent effect of war conditions is confirmed by evidence from other countries and by the fact that during the present War the ratio has again risen to more than 106. The effect may well, as Martin[6] suggests, be due to lowering of the age of parents. The excess of males at birth is only temporary. Infant- and child-mortality fall differentially on the males, and the excess found at birth is abolished before or early in the reproductive period, and thereafter there is always an excess of females. The reduction in the infant and child mortality-rate has been associated with a raising of the age at which the excess of males disappears and a decrease in the excess of females in later age groups, but it is not certain that this factor will operate any further.

The purpose of this note is to lay emphasis on another aspect of the differential mortality problem, the prenatal wastage of lives, particularly of male lives. The amount of prenatal mortality from the time of conception to the time of birth is known to be considerable in many mammals, figures so high as 40 per cent or more having been determined. In man, the prenatal mortality cannot be estimated with any accuracy, but it is probably at least 20 per cent and may be much higher. Most of the information then available on this subject was summarized by me[7] some years ago.

This prenatal mortality in man will not depress the birth-rate to a corresponding extent, since it must often happen that, where fertility is good, the unsuccessful termination of one pregnancy allows of another one which would not otherwise have occurred. Nevertheless, it must exert a certain influence, and it is clear that a substantial decrease in prenatal mortality would lead to a rise in the birth-rate. More important, however, is the sex incidence of abortions, etc., which has been the subject of a number of researches. The earlier literature is summarized in the review referred to above. Almost all investigators agree that prenatal loss, like infant mortality but more so, falls differentially on the males. Auerbach[8], for example, found that there were 156 males per 100 females among more than 4,000 fœtuses aborted between the fourth and seventh months. The proportion of males was greater among the younger abortions. More recently, Russell[5] has given figures from American sources in which prenatal deaths under four months included 375 males per 100 females.

Two implications follow from observations such as these. First, it is quite clear that in man, as in some lower mammals, the proportion of males is much higher at conception than at birth. Anything approaching accuracy is impossible in the present state of our knowledge, but it is likely that in man there are at least 120 males to every 100 females at conception. This conclusion is curious in the light of the fact that X- and Y-spermatozoa are produced in equal numbers; but various explanations, which

are outside the scope of this article, can be offered. Secondly, it is evident that the amount of prenatal mortality must have considerable influence on the sex-ratio at birth. Many years ago, Tschuprow[9] concluded that the sex-ratio at birth was largely determined by the amount of prenatal mortality. This generalization requires various qualifications—allowance for the sex-ratio at conception, for example—but all subsequent work has tended to emphasize the influence on the sex-ratio at birth of the decrease in the proportion of males which takes place during the gestation period. For example, the greater number of males born to younger mothers is probably due to decreased prenatal mortality[10].

From the point of view of population problems, the important aspect, as Groome[4] pointed out, is that a substantial decrease in prenatal mortality would give an increase in the proportion of males born. If the sex-ratio at conception is 120, and 20 per cent of the fœtuses, having a sex-ratio of 200, die before term, then the ratio at birth will be a little more than 106. If the prenatal mortality were halved and retained the same sex incidence, the ratio at birth would be more than 113. Such an increase, coupled with the present reduction in infant mortality, would ensure an excess of males at reproductive ages and would do much to reduce or abolish the excess of females with no chance of marriage. This long-term effect would seem to be of real potential importance in counterbalancing the declining birth-rate, and an intensive programme of research on the causes and prevention of prenatal death offers one of the more promising medical contributions to the problem. Such a line of attack, unlike many projects designed to raise the birth-rate, could arouse opposition only from the sternest exponents of the principle of natural selection.

[1] Registrar General's Statistical Review, 1913.
[2] Registrar General's Statistical Review, 1925.
[3] Registrar General's Statistical Review, 1935.
[4] Groome, J. R., *Eug. Rev.*, **29**, 154 (1937).
[5] Russell, W. T., *J. Hygiene*, **36**, 381 (1936).
[6] Martin, W. J., *Lancet*, **245**, 807 (Dec. 25, 1943).
[7] Parkes, A. S., *Biol. Rev.*, **2**, 1 (1926).
[8] Auerbach, E., *Arch. f. Rassen. und Gesellschafts Biol.*, **9**, 10 (1912).
[9] Tschuprow, Al. A., *Bull. Inst. Int. Stat.*, **20**, 378 (1915).
[10] Parkes, A. S., *J. Genetics*, **14**, 39 (1924).

NEWS and VIEWS

Sir Napier Shaw, F.R.S.

On March 4 Sir Napier Shaw attains the age of ninety years. The present generation may be surprised to know that he had a distinguished career as a physicist before he took any part in meteorology. He was educated at King Edward's School, Birmingham, and at Emmanuel College, Cambridge, of which he was fellow during 1877–1906. He was University lecturer in experimental physics during 1887–99, and with Sir Richard Glazebrook was demonstrator in physics at the Cavendish Laboratory; their joint "Text-Book of Practical Physics" was a household word to students of physics of a generation ago. Sir Napier was elected to the Royal Society in 1891 and it was not until six years later that he was officially connected with meteorology, when he became a member of the Meteorological Council, a body responsible for the Meteorological Office. He became director of the Office in 1905. Then under his influence began a period of great advances in the science along many lines. He had the gift of stimulating the interest and enlisting the help not only of those working directly under him, but also of those outside his official orbit, and his ungrudging help is gratefully remembered by many.

Sir Napier retired from the Meteorological Office in 1920, but he did not retire from meteorology; in 1926 there appeared the first volume of his monumental "Manual of Meteorology", completed in 1931; a second edition of volume 2 appeared in 1936. A much enlarged and revised edition of his "Drama of the Weather" appeared so lately as 1939. These works show Sir Napier's energy at an age when many would have rested on their laurels. Honours have been showered on him by universities and societies both British and foreign. He was knighted in 1915. He was president of the International Meteorological Committee during 1907–23, of the Royal Meteorological Society during 1918–20, of Section A (Mathematical and Physical Sciences) of the British Association in 1908, and of Section L (Education) in 1919. In 1885 he married Sarah Harland, who ably helped him, whether when he was tutor of his College or later when he had to preside over meetings national and international; she died in 1923. Meteorologists and many others will join in all good wishes for Sir Napier's ninetieth birthday.

John Theophilus Desaguliers (1683–1744)

In the later years of Newton's life, there were few figures better known among the men of science in London than that of the short, thickset, near-sighted but broadminded and generous Frenchman, John Theophilus Desaguliers, who died on February 29 two hundred years ago in his lodgings near Covent Garden. Born at La Rochelle on March 12, 1683, he was brought to England by his father at the Revocation of the Edict of Nantes in 1685, and spent the remainder of his life here. At first his father was minister of the French chapel in Swallow Street, London, but also had a school at Islington. The son helped his father and then proceeded to Christ Church, Oxford, and after taking his degree qualified for the Church. In 1710 he was appointed successor to Keill as lecturer in natural philosophy at Hart Hall, and three years later removed to Westminster, living first in Channel Row and then over the Bedford Coffee House, lecturing with great success year after year to "persons of all ranks and professions and even the ladies". He gained a reputation, too, by his translation of s'Gravesande's "Elements of Natural Philosophy". For many years he was demonstrator to the Royal Society and it was to him that the first actual Copley Medal was given, although both he and Stephen Gray had previously received monetary awards under the Copley bequest. As a clergyman he held various livings, one of these being that of Whitchurch, Middlesex, of the church of which Handel was organist. In his works he gives full particulars of the many experiments he made and also much information about the principal mechanical constructions of his time. His death took place when he was nearly sixty-one, and he was buried in the Savoy. One of his sons, Thomas Desaguliers (died 1788), for many years superintended Woolwich Arsenal, and was the first scientific investigator into gunnery in the British Army.

Pascal's Arithmometer

At a well-attended meeting of the Newcomen Society held in the rooms of the Royal Society on February 16, Mr. R. Nilsson gave a paper entitled "The Pascal Arithmometer and Other Means to Solve Mathematical Problems". The audience included many distinguished foreigners. Premising that accuracy in calculation is one of the most important elements in scientific progress, Mr. Nilsson said that by a calculating machine is understood a great number of working parts conjoined in action by various mechanisms to obtain arithmetical or algebraic results. Describing in detail, with the use of slides, the arithmometer invented by Blaise Pascal (1623–62) when a youth of nineteen, the author said that Pascal's basic invention was the 'ten-carry-over' which is seen in the counters, meters, cash registers, etc., which are part and parcel of our daily life. Two years were occupied in making the first machine, and more than fifty models were constructed before the machine was in working order. Pascal showed it in 1647 to Descartes and in 1649 to Chancellor Séguier, who helped him to obtain a patent. Mr. Nilsson mentioned the machines which succeeded Pascal's; Sir Samuel Morland's (1666), that of Leibniz (1672), and those of Grillet, Poleni and Charles Xavier Thomas, of Colmar, Alsace, who began the manufacture of calculating machines. In the ante-room was a representative exhibition of machines and documents. In proposing a vote of thanks to the Royal Society for its hospitality, the chairman, Eng. Captain E. C. Smith, said that there could be no more suitable place for the gathering. Pascal was associated with some of the French men of science whose meetings led to the founding of the French Academy of Sciences, and his death coincided with the grant of the Act of Incorporation to the Royal Society.

Ankara University: Opening of Faculty of Science

A new Faculty of Science in the University of Ankara was opened on November 8, 1943, in the presence of President Inönü. The President, accompanied by the Prime Minister, Sükrü Saracoglu, was welcomed at the inauguration ceremony by the chairman of the National Assembly, B. B. Abdülhalik Renda. All the members of the Cabinet were present; Mr. R. F. Lucas, of the British Council, was also invited to attend the ceremony. The Minister of Education, Hasan Ali Yücel, in his opening address, referred to Turkish progress during the twenty years since the establishment of the Republic. The consequent changes in the national outlook have developed a need for scientific and technical training which is now enhanced by the mechanization of armed forces in a world at war. Hitherto Turkish educational institutions have lacked equipment for practical training; but Turkey has now an established policy of education based on positive knowledge to reinforce the earlier practice of theoretical training only. The nation needs mechanical engineers, mining and civil engineers, and the great problem of Turkey to-day is to find the means for training students in large enough numbers to satisfy the national requirements without reducing the educational standard. The Government is keenly aware of these needs and has sanctioned the establishment of this faculty as a step to meet them. The assembly was later addressed by the Rector of the Faculty, by a student, and by Prof. Kerim Erin, of the Faculty of Science, University of Istanbul.

The new Faculty is temporarily installed in the Gazi Teachers' Training Institute. The Dean of the Faculty, Bay Hayri Dener, is also professor of physics, and a member of the Board of Education. The chair of chemistry and the presidency of the new Chemistry Institute of the Faculty is held by Dr. Avni Refik Bekman. The Ministry of Education has invited the British Council to nominate British candidates for a professorship in each of the existing Departments of Chemistry, Physics and Mathematics. The establishment of this Faculty thus implements the approval of the Bill recently presented by the Turkish Cabinet to the Chamber of Deputies.

Science in China

A pamphlet entitled "The Place of Science in China" by Yap Pow-Meng, honorary secretary of the National Science Society of China, British Branch, published by the China Campaign Committee, 34 Victoria Street, London, S.W.1 (*6d.*), attributes the failure of the scientific method to establish itself in the intellectual tradition of China mainly to social and economic reasons. From the first, the makers of the revolution of 1911 seized upon science as a means of achieving their ideal of a progressive, industrialized China, and the pamphlet gives a brief account of the organization of education in science, of scientific research institutions, including the Academia Sinica, which is essentially an organization providing facilities for scientific research, the National Academy of Peiping, the Science Society of China, the National Science Society of China, the Fan Memorial Institute of Biology, the Henry Lester Institute for Medical Research, and private technical research institutions, of which the most important is the Hangwai Institute of Industrial Chemistry.

The majority of the research institutions of China were founded in the coastal areas and have now been moved to the west and south-west. Apart from those of the Radium Institute of the Peiping Academy and the Metals Research Institute and Science School of the National Tsing-hua University, Chinese researches in physics and chemistry have not so far been impressive, and in China as elsewhere experimental psychology has not made a complete break from the old philosophical psychology. The pamphlet also includes some account of the organization of science in China's war effort under the National Economic Council, the Ministry of Economic Affairs, the National Resources Commission, the Ministry of Agriculture and Forestry, the National Geological Survey and the National Health Administration, as well of the attempts being made to overcome educational difficulties due to the War.

Isinglass as a Substitute for Human Blood Plasma

Many substances have been tried as substitutes for human blood plasma. Recently (Nature, **153**, 145; 1944) reference was made to the use of 'despeciated bovine serum'. A recent note (*Edin. Med. J.*, **50**, 758; 1943) describes the use of isinglass, which is available in sufficient quantities and can be cheaply prepared, as a substitute for human blood plasma. Its injection causes no antigenic response. Prof. N. B. Taylor and Miss M. S. Moorhouse (*Canad. Med. Assoc. J.*, **49**, 251; 1943) transfused 25 dogs from which 47–71 per cent of the blood had been bled, with 4 or 6 per cent solutions of isinglass, and most of the dogs made a complete and uneventful recovery. Repeated injections over a period of weeks caused

no changes in the viscera, and isinglass does not interfere with the normal regeneration of the blood plasma. H. E. Pugsley and R. F. Farquharson (*Canad. Med. Assoc. J.*, 49, 262; 1943) gave the isinglass solution 58 times to 51 human patients to test it for pyrogenic and other toxic effects. A slight rise of temperature occurred on eight occasions, but no other unfavourable signs were noted in the other cases. When the isinglass was given to patients suffering from acute hæmorrhage, extensive burns, compound fractures and severe circulatory failure, the results were all good, and there were no toxic effects. The amount given varied from 200 c.c. to an infant to 8,800 c.c., given over a period of three days, to an adult.

Oil from the Sunflower Plants

There are probably few countries of the temperate regions which have a superabundance of fats and oils. War-time conditions, moreover, always accentuate any deficiency, and turn attention upon the possibilities of home production. A recent paper by E. F. Hurt (*J. Roy. Hort. Soc.*, 68, Part 11; Nov. 1943) gives the results of experience with the sunflower crop. Oil from the seeds of this crop is useful for edible and culinary purposes, for making margarine, as food for cattle and poultry, for canning fish and making fine soap. Its gastronomic value is equal to the finest olive oil. The crop is widely tolerant of soil types, but removes large quantities of soil nutrients, most of which are retained in the stalk, and can be returned to the ground after harvest. Sowing the seed at an even depth of 1½–2 in. appears to be important, and 7½ lb. of seed is needed to sow an acre by drill. Sunflower is a good cleaning crop, and appears to be but little affected by disease, though it is susceptible to wireworm attack and the depredations of birds at harvest time. Three semi-dwarf varieties—'Mars', 'Pole Star' and 'Southern Cross'—are suggested for Great Britain, and as the supply of fats and oils may be one of the most acute of post-war agricultural problems, the crop appears worthy of more extended trial.

Thermoplastic Electric Cables

A PAPER on thermoplastic cables, read by Dr. H. Barron, J. N. Dean and T. R. Scott on February 10 before the Institution of Electrical Engineers, reviews the circumstances which have led to a considerable increase in the use of thermoplastic cables within the last few months. It is pointed out that the relative importance of such cables cannot yet be evaluated on a peace-time basis, for the economic level cannot be established and also synthetic rubber is now making its appearance. In order to establish a basis for evaluation, it is desirable to have a thorough understanding of the general characteristics of thermoplastic cables; this is attempted in the paper with particular reference to polyvinyl chloride cables. Indications are given of the polymer situation, the definition of a thermoplastic material and the resulting implications. The building-up and testing of polyvinyl compounds is discussed, and the manufacture, characteristics and uses of cables derived therefrom are considered in detail. A brief survey of other thermoplastics is followed by a comparison of polyvinyl chloride with rubber.

It is concluded that suitably selected thermoplastic compounds can produce satisfactory wires and cables the characteristics of which are such that the corresponding rubber cables can be replaced by these thermoplastic cables. Oxidation need no longer be considered as the predominant factor in determining life; there are still restricting factors which prevent thermoplastic cables from being worked at temperatures appreciably in excess of those suitable for rubber cables; but these factors are of a different nature and may be countered by development and design along lines which would be impracticable for rubber. The cable engineer has acquired a range of alternate materials which, while they present problems of their own, promise interesting solutions for some existing problems. A period of rapid development of wires and cables of compound characteristics must inevitably ensue so soon as free choice, on an economic basis, of such materials is practicable.

Industrial Fire Risks

IN a paper read in London on December 9 before the Institution of Electrical Engineers, Messrs. W. Fordham Cooper and F. H. Mann describe first the classification of buildings and structural materials in relation to fire resistance, and then deal with the hazard from various industrial materials and processes and the special precautions which should be adopted in providing and operating electrical installations in view of these risks. Flame-proof and intrinsically safe constructions are briefly described. The second part of the paper illustrates the application of the matter discussed in the first part; but, as it is impossible to deal with every risk, attention has been particularly paid to the heavy chemical (gas, coke and by-product) and textile industries by way of examples, although some other matters, notably switch and transformer oil-fire risks, are also mentioned.

Tuberculosis in Paraguay

IN a recent article (*Bol. Of. San. Panamer.*, 22, 318; 1943), Drs. A. R. Ginés, A. Alvarez and M. Mercado state that in June 1941 the control of tuberculosis in Asunción was started under the direction of Dr. Angel R. Ginés, and 40,000 persons were examined in the course of a year. In November 1941, the Ministry of Health amended a decree of 1938 making compulsory the X-ray examination of all public officers, public and private employees, teachers, students, labourers, etc. The examination consisted of a tuberculin test, pulmonary röntgenograms or sometimes merely fluoroscopy and a rapid examination of the skin and mucous membranes. The Tuberculosis Dispensary at Asunción, which was founded in 1922, during the first ten years of its existence could treat only general advanced tuberculosis owing to the lack of modern means of diagnosis; but in 1932 a chair of tuberculosis was created and the campaign against tuberculosis now includes a röntgenological and tuberculin survey and a morbidity and mortality survey in the urban areas of the Republic, diagnosis of the disease by modern methods, effective isolation or quarantine of contagious cases, creation of schools for the tuberculous or pre-tuberculous, vaccination of the newborn with B.C.G., economic and social improvements, creation of an Institute of Social Security, intensive educational propaganda, and eradication of tuberculous animals. The tuberculosis death-rate is calculated to be 199·9 per 100,000, and its relation to general mortality is 15·50 per cent. Tuberculosis with other diseases of the lungs caused a third of the deaths in 1941. Relation to the standard of living is supported by the following death-rates:

merchants 3 per cent, intellectuals 6 per cent, seamstresses, domestic helpers and other employees 10–11 per cent, farmers 22 per cent and labourers 29 per cent. The highest death-rates were noted in the 1–5 year old group and in the 20–40 group.

Immunizations in Large Cities of the United States

In a recent paper (*Public Health Rep.*, 58, 1121; 1943), Selwyn D. Collins, head statistician, and Clara Councill, assistant statistician of the United States Public Health Service, record their study of immunization against diphtheria, smallpox, scarlet fever and typhoid fever based on a canvas of 213,931 households in 23 cities of 100,000 or more inhabitants. Their conclusions are as follows. Immunizations against scarlet fever and typhoid fever are negligible compared with those against diphtheria and smallpox. In the pre-school age immunizations against diphtheria are more frequent than vaccinations against small-pox, but after five years the reverse is true. There was considerable geographical variation in the extent of immunization against the diseases. In the north, for example, the percentages of native, foreign and coloured children of specific ages immunized against diphtheria are approximately the same, while in the south a higher percentage of the native whites is immunized than of the foreign whites or coloured.

Cattle Fodder from Wood

According to an annotation entitled "Fir to Fodder" in the January issue of the *Anglo-Swedish Review*, the Swedish forests provide a practically inexhaustible store of timber which can be converted into fodder for horses and cattle. It can be made from the wood of the fir tree, but pine can also be used. The raw wood has no food value for man, even if ground to a fine flour, as there are no enzymes or micro-organisms in the human digestive tract to dissolve the wood and its cellulose. Cattle and horses, however, can absorb it almost entirely because their digestive organs contain bacteria which can break down the pure cellulose into products which can be absorbed into the blood. To make the fodder cellulose more nutritive and palatable to animals, molasses and sometimes phosphates or salts are added at the pulp mill. Alcohol is also obtained during the process of making fodder pulp.

Research in Human Nutrition

The Medical Research Council has established a Unit for Research in Human Nutrition as part of its staff organization, and Dr. B. S. Platt has been appointed its director. Temporary accommodation has been provided at the National Hospital for Nervous Diseases, Queen Square, London. Some part of the investigations undertaken by the Unit will be directed towards nutrition problems in the tropics. Among other things, Dr. Platt will continue the work, for which he joined the Council's staff in 1938, of co-ordinating a programme of nutritional investigations in the Colonies by arrangement between the Colonial Office and the Council.

Properties and Uses of Diamonds

A research department has been established by the Diamond Trading Company, Ltd., the London office of which is at 32–34 Holborn Viaduct, London, E.C., under the management of Mr. Paul Grodzinski, assisted by a staff of five. The Department is engaged in investigations into the properties of diamonds, their preparation for use and, in particular, their application in industry. An extensive library, built up over a long period of years by Mr. Grodzinski, forms part of the Department, and its information service is available free of charge.

The Night Sky in March

Full moon occurs on March 10d. 00h. 28m. U.T., and new moon on March 24d. 11h. 36m. The following conjunctions with the moon take place: March 2d. 08h., Mars 6° N.; March 2d. 13h., Saturn 3° N.; March 7d. 11h., Jupiter 0·1° S.; March 22d. 16h., Venus 2° N.; March 29d. 23h., Saturn 2° N.; March 30d. 18h., Mars 5° N. The following occultations of stars brighter than magnitude 6 take place: March 3d. 19h. 59·4m., ν Gemi. (*D*); March 28d. 20h. 31·1m., 63 Tauri (*D*); March 31d. 19h. 23·5m., ζ Gemi (*D*). The times refer to Greenwich and *D* refers to disappearance. Mercury rises at 6h. 44m. and 6h. 05m. at the beginning and end of the month, but is too close to the sun for good observation. The planet is in superior conjunction on March 17. Venus, a morning star, rises at 5h. 34m. and 5h. 14m. at the beginning and end of the month, and can be seen only with difficulty. Mars sets at 2h. 54m. and 2h. at the beginning and end of the month and can be seen in the early part of the night. On March 7d. 15h. there is a conjunction between Mars and Saturn, Mars being 3·4° N. Jupiter is visible throughout the night, setting at 6h. 15m. and 4h. 13m. at the beginning and end of the month. Saturn is visible in the early part of the night, setting at 2h. 40m. and 0h. 49m. at the beginning and end of the month. Spring equinox begins on March 20d. 18h.

Announcements

Dr. Harry R. Ricardo, the well-known consulting engineer and authority on the internal combustion engine, has been elected president of the Institution of Mechanical Engineers for the year 1944–45.

J. P. Rutland (*New Phyt.*, 40, 210; 1941) has published a supplement to the Merton Catalogue of Chromosomes of British Plants. The new list contains about a hundred new chromosome numbers discovered by the author and other workers, and is a valuable contribution to the analysis of the British flora.

The following appointments have recently been made in the Colonial Service: H. Doggett to be agricultural officer, Tanganyika; A. J. Browning to be assistant conservator of forests, Sierra Leone; S. L. Finding to be assistant conservator of forests, British Honduras; H. Tordoff to be assistant conservator of forests, Trinidad; A. W. Vaughan to be veterinary officer, Jamaica; Dr. E. F. Thompson to be fishery officer, Jamaica; D. W. Duthie (chemist, British Guiana) to be soil chemist, East African Agricultural Research Bureau, Tanganyika; A. F. A. Lamb (assistant conservator of forests, Nigeria) to be senior assistant conservator of forests, British Honduras.

Erratum. In the paragraph entitled "Road Research" in Nature of February 12, p. 193, the names of Major H. E. Aldington (chairman) and Mr. W. Savage were inadvertently omitted from the list of members of the committee.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Nature of Peptones

IN a letter published in NATURE[1], a method was described by us whereby the ratio

$$\frac{\text{N-total cleavable}}{\text{N-split hydrolytically}}$$

may be easily computed, and hence the extent of cleavage which has been performed by one or several proteinases acting on a given protein or peptone determined. Since then, still more proteins and peptones have been investigated and it seems desirable to give a brief account of the results achieved. It should be emphasized beforehand, however, that the proteins investigated by us generally showed the same behaviour as regards their cleavability by the proteinases employed irrespective of their physical-chemical properties, chemical composition and source of occurrence, as indicated in Table 1 below.

(1) The ratio $\frac{\text{N-total cleavable}}{\text{N-split hydrolytically}}$ as obtained by exhaustive cleavage with pepsin-hydrochloric acid was in all cases equivalent to a Z value of 4 with the sole exception of casein (Table 1).

TABLE 1.

Substrate	Cleaved exhaustively by	N-total cleavable / N-split hydrolytically
Ovalbumin-pepsin peptone	Pepsin-hydrochloric acid	4·02
,, ,, ,,	Pancreatic proteinase	4·02
Pancreatin proteinase peptone from ovalbumin (cleaved exhaustively)	—	3·96
Fibrin pepsin peptone	Pepsin-hydrochloric acid	4·10
Casein pepsin peptone	,, ,, ,,	4·82
,, ,, ,,	Pancreatic proteinase	3·93
Pancreatic proteinase-peptone from casein	Pancreatic proteinase	3·82

(2) All peptones obtained from proteins by incomplete splitting with pepsin-hydrochloric acid (thus leaving a substantial margin for further action by additional enzyme) are split by the succeeding action of purified pancreatic proteinase (tested as to its freedom from protaminase and polypeptidases) to the above ratio of 4 (Table 1).

(3) Exhaustive cleavage by pepsin-hydrochloric acid followed by exhaustive cleavage by pancreatic proteinase reduced the above ratio in all cases to a value of 3 (Table 2).

TABLE 2.

Substrate	Cleaved exhaustively by	N-total cleavable / N-split hydrolytically
Ovalbumin pepsin peptone	Pepsin-hydrochloric acid followed by exhaustive cleavage with pancreatic proteinase	3·18
Casein pepsin peptone	,, ,, ,,	3·10
Fibrin pepsin peptone	,, ,, ,,	3·09

(4) Proteins split by the action of pancreatic proteinase alone were found to give the same nitrogen ratio as obtained by the action of pepsin-hydrochloric acid, namely, 4 (Table 1).

These results are summarized in the accompanying tables.

The peptones prepared from proteins by cleavage with pepsin-hydrochloric acid as shown in Table 1 were not subjected to exhaustive splitting during the process of preparation, since this would involve the addition of substantial amounts of enzyme carrier protein which might cause aberrations from the real N-values, etc., of the substrates investigated. The further degree of cleavage which might be performed by this enzyme or any other proteinase employed in succession had always been observed in enzyme tests and added to the N-value corresponding to the free (NH_2 + NH)-groups found in the peptone (see ref. 1).

A detailed report will be given elsewhere.

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Jan. 1.

[1] NATURE, 151, 280 (1943).

Growth Stimulation of *L. casei* E. by Pyrimidines

PURINE and pyrimidine derivatives have been shown to be growth stimulators for a number of organisms; uracil has been shown necessary for *L. arabinosus* and *Leuconostic mesenteroides*[1], and the anaerobic growth of *Staph. aureus*[2], thymine for *S. Lactis*[1], adenine for *L. arab.*, *L. pentosus*[1], and adenine and guanine for *L. plantarum*[3]. Adenine, guanine, uracil and xanthine have been included in media for the growth of *L. casei*[4,5], and Feeney and Strong[6] have shown adenine and guanine to be stimulatory for *L. casei* E. under certain conditions.

During work on the purification of unknown factors present in liver and required for the growth of *L. casei* E., it was found that the active material displayed properties which suggested the presence of purine or pyrimidine derivatives, and accordingly a number of synthetic compounds were tested for growth-promoting activity. Of those tried only one was found to give any response, namely, orotic acid (uracil 4-carboxylic acid).

A casein hydrolysate basal medium was used, the same as that described by Chattaway, Happold and Sandford[7] with the inclusion of riboflavin (40 μgm./l.) and biotin (5 μgm./l.) and without the addition of a liver eluate. The inoculation was a loopful of a faintly opalescent suspension of bacterial cells in sterile water, and growth was estimated by titration of the lactic acid produced after 72 hr. incubation at 37° C., using brom-thymol blue as indicator. Titrations from 0·5–2 c.c. N/10 lactic acid have been repeatedly obtained with the derivative mentioned in a minimum concentration of 0·01 μgm./ml. medium, with no growth in control flasks. The response has varied from time to time and on a few occasions there has been no response, and this is ascribed to variations in the casein hydrolysate used, since the concentration of unknown factors in the hydrolysate may vary. Substances which have been found not to

stimulate acid production either alone or in combination and in concentrations ranging from 20 to 0·01 μgm./ml. are adenine, guanine, uracil, thymine, 4-methyl-5-ethoxymethyl uracil, 4-methyl-4:5-dihydro-uracil, 2-methyl-4-amino-5-aminomethyl pyrimidine, 4-methyl-5-amino-uracil and 4-methyl-uracil.

I should like to thank Prof. A. R. Todd and Dr. F. Bergel, of Roche Products Ltd., for supplies of materials, and Dr. F. C. Happold for helpful advice.

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Importance of Pyrimidine Derivatives in the Growth of Group C (Lancefield) Streptococci upon a Simplified Medium

RICHARDSON[1] showed that uracil (2.6 dihydroxy pyrimidine) is necessary for the anaerobic growth of *Staphylococcus aureus*, and more recently Snell and Mitchell[2] have reported that purine and pyrimidine derivatives stimulate the growth of certain lactic acid bacteria. Möller[3] had previously claimed that adenine and guanine increase the growth of *Lactobacillus plantanum*. Pappenheimer and Hottle[4] showed that uracil is not necessary for the growth of a strain of hæmolytic streptococcus Group *A*. The latter authors reported, however, that purine derivatives are necessary for this organism unless the carbon dioxide tension in the atmosphere above the culture is high. At a partial pressure of 40 mm. mercury of this gas, rapid and optimal growth occurs without the addition of purines to the medium.

It was found here that a strain of Group *C* (Lancefield) type 7 (Griffiths) hæmolytic streptococcus (called *C*7) gave only slight and variable growth upon a casein hydrolysate medium unless this was supplemented by uracil. The casein hydrolysate basal medium was similar to that designed by Bernheimer, Gillman, Hottle and Pappenheimer[5], except that biotin, which is not necessary for the growth of *C*7 upon the casein medium, was omitted. Bicarbonate, and, of course, uracil were also not added. The growth-factors present were thiamine, nicotinic acid, pyridoxin, calcium pantothenate, riboflavine, adenine and glutamine. It is probable that not all these factors were necessary for the growth of the organism, but they were included in the medium for completeness. The glucose concentration was 0·25 per cent.

Two inocula were used: the first (I) was three drops of faintly opalescent suspension of bacterial cells in isotonic saline per 10 ml. of medium. The cells were from a 6–7 hour broth culture of *C*7 and were twice washed with saline. The second inoculum (II) was three drops of a 1/100 dilution of (I) per 10 ml. of medium.

Table 1 shows the mass of growth, as milligrams of bacterial N per 50 ml. of culture, after twenty-four hours incubation at 37° C. in the medium supplemented by uracil or orotic acid (uracil-4-carboxylic acid).

TABLE 1. INFLUENCE OF ADDING VARIOUS AMOUNTS OF URACIL AND OROTIC ACID TO THE BASAL MEDIUM, UPON THE GROWTH OF STREPTOCOCCUS *C*7.

Mgm. of uracil or orotic acid added per 10 ml. of medium	Growth in mgm. bact. N per 50 ml. of medium					
	Inoculum I			Inoculum II		
	Uracil		Orotic acid	Uracil		Orotic acid
	Exp. *a*	Exp. *b*	Exp. *a*	Exp *a*	Exp. *b*	Exp. *a*
0	5·9	2·3	6·6	3·8	0·7	3·9
0·005	—	3·4	6·1	5·2	0·7	3·5
0·02	9·2	6·0	7·4	8·1	3·5	7·5
0·10	12·5	—	11 5	—	—	10·8
0·20	10·0	8·6	10·2	10·0	10 0	11·2

The amount of growth which occurred in the media containing only small amounts of the pyrimidine derivatives was variable but did not increase during a further twelve days incubation. The addition to the medium of 10–20 μgm./ml. of uracil or orotic acid, however, resulted in growth as good as that in peptone broth cultures.

Increased carbon dioxide tension up to 50 mm. mercury had no influence on the mass of growth that occurred in any of the media. Complete removal of carbon dioxide from the atmosphere above the culture inhibited the growth of inoculum II but not I, even in the presence of 20 μgm./ml. of uracil.

Four out of five of the strains of Group *C* streptococci of various types which were tested also needed uracil or orotic acid for optimal growth. The two pyrimidine derivatives were equally effective in increasing both the rate and mass of growth of these organisms. Table 2 summarizes these results and includes *C*7 for comparison.

TABLE 2. INFLUENCE OF URACIL AND OROTIC ACID (EACH AT A CONCENTRATION OF 0·10 MGM. PER 10 ML. OF MEDIUM) UPON THE RATE AND MASS OF GROWTH OF GROUP C STREPTOCOCCI. THE INOCULUM USED WAS OF STRENGTH II ABOVE.

Strain	Basal medium		Basal medium + uracil		Basal medium + orotic acid	
	M	*T*	*M*	*T*	*M*	*T*
Mare (2)	++	4 days	++++	40 hr.	++++	40 hr.
Mare (3)	+	5 ,,	++++	20 ,,	++++	20 ,,
Loewentahl *M*	+++	6 ,,	++++	60 ,,	++++	40 ,,
Loewentahl *O*	+++	40 hr.	+++	40 ,,	+++	40 ,,
Human (20)	+	5 days	++++	16 ,,	++++	24 ,,
*C*7	+ to ++	40 hr.	++++	20–40 ,,	++++	20–40 ,,

M equals final mass of growth; *T* equals time to reach maximum growth.

My thanks are due to Dr. F. Bergel, of Roche Products, Ltd., for helpful advice and the supply of growth factors, and to Prof. A. R. Todd for the supply of synthetic uracil and natural orotic acid.

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Sodium Sulphate as an Agent Causing the Development of the 'Chloride-secreting Cells' in Macropodus

IN an earlier paper[1], I have reported the enormous development of the 'chloride-secreting cells' in the branchial lamellæ of the paradise fish acclimatized in a table-salt solution of salinity 27·3 per cent. As these cells are very scanty and rudimentary in the control specimens, the conclusion was drawn, in harmony with the suggestion of Keys and Willmer[2], that they are intimately concerned in the undertaking of osmotic regulation against a hypertonic external medium. The question now arises as to whether the secretory activity of these cells is restricted to chloride alone, as their name implies, or is of a more general nature, capable of turning out salts other than chloride.

To shed light on this problem, I have conducted an acclimatization experiment on *Macropodus opercularis* similar to that described in the earlier paper (*vide supra*), except that Merck's extra pure crystals of Glauber's salt ($Na_2SO_4.10H_2O$) was employed in substitution for the table-salt. Commencing on March 12, 1942, 0·5 gm. of that salt was introduced daily into the 3,000 c.c. jar, which housed four individuals, until May 10 inclusive. Then the daily dose was increased to 1 gm. from May 11 to May 20 inclusive, to 2 gm. from May 21 to June 9 inclusive, to 3 gm. from June 10 to June 19 inclusive, and up to 4 gm. from June 20 to June 24 inclusive. At the close of the course of acclimatization, the *milieu extérieur* was composed of a Glauber's salt solution of 3·83 per cent strength (since a total of 115 gm. had been dissolved in 3,000 c.c. of water), and in this the fish lived, apparently with depressed appetite, for four days before they were killed and their gills fixed (on June 29). Microscopic examination revealed quite a number of the 'chloride-secreting cells' at the base of the branchial lamellæ, the larger ones of which sometimes measured $12\mu \times 9\mu$ in size. Although not so prominent as those acclimatized in the table-salt solution, these cells are clearly evident and much more well-developed in comparison with the control specimen, so it is scarcely possible for them to be wrongly identified.

The result thus obtained points to a non-specificity of the secretory activity of these cells. As the external medium is practically chloride-free and owes its osmotic gradient exclusively to the sulphate, there is no reason to think that these cells should secrete chloride instead of sulphate under such a condition. The development of such cells in a hypertonic sulphate solution can most easily be interpreted on the assumption that these cells are secreting the sulphate, for in this way water could be freed and osmo-regulation effected. Accordingly, I suggest that the substance destined to be secreted would not necessarily be chloride in all instances, but would vary according to the chemical nature of the environment, and would probably correspond to the osmotically active substance in the external medium. In the case of a marine environment, the osmotically active substance is naturally the chloride, hence chloride is secreted by these cells[3]. In the present experiment, however, sulphate should be expected, inasmuch as it is the only osmotically active substance present.

That the 'chloride-secreting cells' develop in response to a sulphate medium tends to weaken the conclusion reached by Smith[4] that "SO_4, like Ca, Mg and PO_4, is excreted exclusively by the kidneys". According to his opinion, sulphate should combine with sodium, to be excreted afterwards by the kidney, as he puts it : "In the absence of other salts, SO_4 takes Na into the urine with it, . . ." If so, then the burden of osmotic regulation in a hypertonic sulphate solution would appear to have been borne by the renal organs rather than the gills. But this is wellnigh impossible in view of the osmotic limitation of the fish kidney. Based on the result of the present experiment, considering the 'chloride-secreting cells' as the anatomical basis for hypertonic excretion, I suggest that divalent ions, at least the sulphate, might also be secreted extra-renally by these cells. Determination of the secretion of these cells by direct chemical methods is much required to settle this question.

I wish to express my gratitude to Dr. H. W. Wu, at whose suggestion the present work was carried out.

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Congenital Porphyria in Pigs

CONGENITAL porphyria in animals was first described by Fourie and Rimington[1], who found the condition in cattle in South Africa. The most striking features of the disease are the colour of the bones due to the deposition of uroporphyrin and other pigments, and the excretion of considerable amounts of porphyrin in urine and faeces. The finding of such pigmented bones in cattle and swine in slaughterhouses has been reported from time to time (for review see ref. 2), but so far as we are aware no living domestic animals other than South African cattle have been available for study.

Recently, some pig bones showing a reddish-brown discoloration were sent to the Animal Research Station, Wallaceville, by Mr. J. A. Chenery, supervising meat inspector at Waitara. The bones gave a brilliant red fluorescence in ultra-violet light and were found to contain uroporphyrin I. Congenital porphyria was therefore suspected. When a second pig from the same farm was found to show similar symptoms, it was possible to trace the sow which was producing offspring with pigmented bones. A urine sample from this sow was dark red, with absorption bands, after acidification, at 555 and 600 mμ, and on extraction yielded uroporphyrin I and coproporphyrin I, together with small amounts of the series III isomers. The fæces contained coproporphyrin I and traces of coproporphyrin III.

Full details of the chemical examination of material from this sow and affected progeny will be given elsewhere ; here it is sufficient to state that the nature and type of the porphyrins obtained resemble those found in human and bovine congenital porphyria. The sow appears to be the first living case of congenital porphyria in pigs which has been examined.

Fourie[3] has shown that in South African cattle the disease is inherited as a recessive character. Information so far available on the breeding of the pigs is incomplete, and no conclusions as to the mode of inheritance can be drawn. The affected sow is of mixed breeding, out of a Tamworth-Berkshire-

Large Black dam by a pedigree Tamworth sire. When first examined she had produced two litters by a Tamworth boar (Boar *A*), and has since given birth to a third litter by another Tamworth (Boar *B*) which is a half-brother, on the sire's side, to Boar *A*. Such details as can be obtained on the occurrence of offspring with pigmented bones in these three litters are given in the following table:

Litter	No. in litter	Pigmented	Normal	No information	Sire
1	10	1	–	9	Boar *A*
2	10	2	3	5	Boar *A*
3	7	2	5	0	Boar *B*

A full sister to the affected sow, mated to Boar *B*, produced 14 pigs none of which had coloured bones. Both boars appear to be clinically normal.

The porphyria sow shows no symptoms of the photosensitivity which often accompanies congenital porphyria; but as she is black all over, this is not unexpected.

The sow and Boar *A* have both been purchased by this Research Station for breeding experiments and chemical studies.

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Treatment of a Virus Disease of Chickens with Sulphonamides

BLAKEMORE has published[1] an account of a disease produced in young chicks by the inoculation of suspensions of tissues from typical cases of fowl paralysis (neurolymphomatosis). While the lesions were superficially unlike those of typical fowl paralysis, the course and pathology suggested that the experimentally produced disease was an acute form of fowl paralysis. Glover[2] produced a similar disease in chickens by the inoculation of tissue suspensions from a turkey affected with neurolymphomatosis. It was shown that the infective agent was filterable[3]. During the course of experiments which have been carried out in this Laboratory, a number of strains of virus which originated from paralysed fowls have been studied. Intraperitoneal inoculation of young chicks with virus results in the production of lesions which are primarily necrotic and are most conspicuous in the liver and heart. Visceral lesions become visible to the naked eye 48–72 hours after inoculation. They increase in extent and frequently reach maximum severity 6–8 days after infection. In the experiments recorded here, all chicks were killed 5–10 days after infection. Diagnosis was based upon the presence or absence of macroscopic lesions.

The influence of sulphonamides in the treatment of this disease has been striking. For ease of administration the sulphonamides have been mixed into the food or dissolved in the drinking water. Chickens treated continuously from the time of inoculation until the time of killing failed to develop lesions and their tissues proved to be non-infective. Treatment commenced at the time gross lesions were established resulted in the arrest and resolution of the disease process. A total of 138 chicks inoculated with eighteen strains of virus have been treated with sulphadiazine mixed in the food at a level of $\frac{1}{24}$–$\frac{1}{8}$ gm. per oz. None has developed macroscopic lesions. Of 117 control infected untreated chicks, 101 showed gross lesions on post-mortem examination.

The disease is sensitive to treatment with most of the sulphonamides in common use. As judged by the smallest dose necessary to prevent the development of gross lesions, the value in descending order is sulphadiazine, sulphamezathine, sulphathiazole, sulphapyridine, sulphaguanidine. The toxicity of sulphanilamide to chicks is such that it proved valueless.

The action of sulphonamides in this condition appears to be similar to that in bacterial infections. It is neutralized by *p*-aminobenzoic acid. A virus-containing suspension remained infective for more than twenty-four hours when prepared in a saturated aqueous solution of sulphathiazole and kept at room temperature.

The observation that this virus disease responds to sulphonamide treatment is of special interest, since apart from lymphogranuloma inguinale and possibly trachoma, virus diseases have proved refractory to chemotherapy.

The effect of sulphonamide treatment on the clinical condition and infectivity of fowls affected with typical fowl paralysis is being studied. It is clear that much careful work will be required in order to determine if means exist whereby sulphonamides might be employed in an attempt to control fowl paralysis. The low economic value of the individual fowl imposes obvious limitations upon the medical treatment of the diseases of poultry.

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Urease Activity and Ascorbic Acid

IN a recent note, Elson[1] has shown that ascorbic acid at low concentrations inhibits urease activity, and that this inhibition is prevented by addition of cysteine. Quastel[2] suggests that the inhibition of the activity by ascorbic acid is due to the oxidized form of ascorbic acid, namely, the diketone (dehydroascorbic acid) and not to the ascorbic acid itself. The disappearance of the inhibition on the addition of cysteine has been attributed to the reduction of the dehydroascorbic acid to the inert ascorbic acid. It seemed to us more probable that the action of ascorbic acid is not connected with either ascorbic acid or dehydroascorbic acid, but with the oxidation of the vitamin by traces of heavy metals like copper present in the reaction mixture. For several years we have been investigating the influence of ascorbic acid on enzymes, and we have obtained results showing that the vitamin as such or the dehydroascorbic acid has very little influence on the enzymes (phosphatases and amylase); but when the vitamin is oxidized by traces of copper present in the reaction mixture the enzyme is inhibited to a considerable extent. It was also found that substances which inhibit the oxidation of ascorbic acid annul the inhibition by the vitamin. In the light of these results we have now investigated the influence of ascorbic acid,

dehydroascorbic acid and substances which inhibit the oxidation of the vitamin, on urease. The experimental method adopted was as follows.

Briefly, it consists in incubating a mixture of solution containing 0·5 c.c. of urease (prepared by extraction of jack bean powder with water), 3 c.c. acetate buffer $M/5$, pH 6·0 and the substance under investigation in a total volume of 8·0 c.c. for 30 min. at 30° C. At the end of this period, urea (2 c.c. of 3 per cent) was added to the mixture, and the ammonia formed at the termination of a subsequent 30 min. incubation at 30° C. was estimated by the usual aeration method. Representative results showing the effect of ascorbic acid, dehydroascorbic acid and substances which inhibit the oxidation of the vitamin on the activity of the enzyme are given in the accompanying table.

	Ammonia formed after 30 min. (mgm.)		Ammonia formed after 30 min. (mgm.)
Exp. No. 1.		Exp. No. 3.	
Urease	7·6	Urease	2·1
Urease + ascorbic acid (1 mgm.)..	2 6	Urease + ascorbic acid (1 mgm.) ..	0·0
Urease + dehydroascorbic acid (prepared by Norit oxidation of ascorbic acid)	6·9	Urease + ascorbic acid (1 mgm.) + 8-hydroxyquinoline (2 mgm.) ..	2·0
Exp. No. 2			
Urease	8·3	Urease + ascorbic acid (1 mgm.) + sodiumdiethyldithiocarbamate (2 mgm.)	2·1
Urease + ascorbic acid (1 mgm.)	2·4		
Urease + ascorbic acid +(1 mgm.)+ creatinine (2 mgm.)	4·6		

The results show that the inhibiting action of ascorbic acid is not due to dehydroascorbic acid, as the degree of inhibition exerted by dehydroascorbic acid is negligible compared with that exerted by ascorbic acid at equal concentration. Furthermore, the fact that the inhibition by ascorbic acid can be prevented by substances other than cysteine, which are known to inhibit the oxidation of ascorbic acid by forming complexes with copper[4], tends to show that the inhibition is due to the oxidation of the vitamin by traces of copper present in the reaction mixture. We believe that the function of cysteine also consists in its combination with traces of copper in the reaction mixture, thereby preventing the oxidation of the vitamin.

Our experiments give further support to the view expressed by us[3] that the inhibition of the activity of enzymes by ascorbic acid is associated with the oxidation of the vitamin, and that those compounds which protect the vitamin from oxidation annul the inhibition produced by the vitamin. The inactivation of urease by ascorbic acid undergoing oxidation catalysed by traces of copper may be attributed to intermediate products such as Cu_2O formed during the oxidation.

Further evidence with regard to the mechanism of the reaction will be adduced in the detailed paper to be published elsewhere.

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Intracellular Localization of Vitamin C

In a recent communication referring to the use of acid silver nitrate to demonstrate the intracellular localization of vitamin C, Barnett and Fisher[1] state: "It is concluded that it is unjustifiable to infer the whereabouts of ascorbic acid within the cell from the site of silver precipitates obtained by the silver nitrate method". The bases for this statement are the results obtained on the staining of mixtures of gelatin and ascorbic acid and olive oil or ground glass with acid silver nitrate.

The authors have apparently assumed, but have produced no evidence, that the vitamin C in such mixtures is evenly distributed. They feel, therefore, that the presence of granules of silver scattered in the mixture and the deposition of silver granules on the surfaces of oil droplets, pieces of ground glass, etc., is an indication that the granules of silver are deposited independently of the distribution of vitamin C. In the first place, the vitamin might well be distributed unevenly in such mixtures; in particular it might aggregate at surfaces, and, in the absence of proof of its even distribution, this suggestion is as likely to be right as any other. In any event the possibility that some of the granular silver deposits seen in cells after the silver nitrate technique may occur, even if the vitamin C is evenly distributed in cells, was made so long ago as 1933 by me[2], but Barnett and Fisher make no reference to this paper.

The presence of granules of silver in Barnett and Fisher's mixtures is the main basis for the argument that there is not sufficient evidence for the existence of vitamin C in the granular mitochrondria of some organs. They do not adduce important evidence in favour of its presence in these organelles. Thus it has been found[3] that in adjacent frozen sections of the same pieces of tissue stained with Janus green B to demonstrate mitochondria and with acid silver nitrate to demonstrate vitamin C, there was an exact correspondence between the mitochondrial and the silver granules. The organs used for this purpose were adrenal cortex and anterior pituitary. Similar results with the adrenal cortex, the anterior pituitary and the corpus luteum were obtained by Leblond[4] and by Giroud[5]. The latter found the morphology and dimensions of the silver granules the same as those of mitochondria and makes the comment, "Leur disposition correspond entièrement à celle du chondriome". Barnett and Fisher have also omitted to mention the results obtained by ultracentrifugation of cells[6].

Barnett and Fisher state that localization of silver granules in the region of the Golgi material in cells is due to the fact that such granules will in any event tend to aggregate at surfaces. They do not explain why, therefore, in vitamin C preparations, silver granules never aggregate on the surfaces of filamentous mitochondria, but say simply that they present "a different type of interface to that of the Golgi apparatus", as though the Golgi apparatus is surface at which granules of silver will easily aggregate. In fact, Silver[7] has explained the well-known fact that reduced silver will not aggregate on the Golgi surface unless the cell has been first treated with salts of certain heavy metals such as uranium. This paper is not referred to by Barnett and Fisher, yet it is particularly relevant to their discussion. Even if we assumed, for the sake of argument, that the Golgi material presented such a surface, they still need to explain why in the cells of some tissues the

Golgi region accumulates silver granules after treatment with acid silver nitrate, and why in those of other tissues it does not; and why the Golgi material in the cells of the one tissue will accumulate silver granules at one time and not at another; while they do not refer at all to Hirsch's[8] comments on the relation of the staining of the Golgi material of cells with the acetic acid silver nitrate reagent and the production of secretory droplets.

If the results of Barnett and Fisher[1] are significant, one would expect that in organs such as the adrenal cortex and the corpus luteum, where there are large numbers of small fatty and lipoidal droplets in the cells, thus paralleling the oil droplets in their preparations, the application of the acid silver nitrate would cause these droplets to become surrounded with black granules, but in fact it does not. In this organ and in other organs containing fatty droplets, Giroud[5] has stated that he has never seen black granules deposited on the surface of the droplets.

One is forced to conclude that Barnett and Fisher's results quoted above need further support than they have given.

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Role of Phosphate in the Methylene Blue Reduction by Dehydroascorbic Acid

WITH reference to the recent publication, by Penney and Zilva[1], on "The Chemical Behaviour of Dehydroascorbic Acid *in vitro* and *in vivo*", I wish to direct attention to my paper "On the Methylene Blue Reducing System of Palestine Orange Peels"[2], the conclusions of which, arrived at by a different method, are supported by the results of the above authors.

While investigating the methylene blue reducing system of orange peels, which was afterwards identified with dehydroascorbic acid (or its irreversible product, diketogulonic acid), it was found that this substance reduced methylene blue, the rate of reduction increasing with increasing pH as from 6·5 to 8·5. But this reaction (which seems to involve the disappearance of diketogulonic acid[3]) proved to be dependent upon the presence of phosphate (which could not be replaced by acetate). I suggested that this explained the discrepancies between Borsook *et al.*[3], who worked with McIlvaine buffer, and Ball[4], who used acetate buffer.

It is interesting to note that Penney and Zilva likewise observed that when they used phosphate buffers (McIlvaine or phosphate-NaOH) "above pH 6, it was found that diketogulonic acid began to decompose, the rate of disappearance increasing with increasing pH", and when they worked with borate buffer, pH 7·4, "the resulting diketogulonic acid was relatively stable and no indophenol-reducing substance was formed from the mutarotating solution".

It is therefore surprising that Penney and Zilva did not note the part played by phosphate, as pointed out in my paper, which is supported by their own experiments, and, as mentioned above, suggests a likely explanation of the discrepancies between Borsook *et al.* and Ball.

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Jan. 17.

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[3] Borsook, H., Davenport, H., Jeffreys, C., and Warner, R., *J. Biol. Chem.*, **117**, 237 (1937).
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Number of Configurations of Molecules Occupying Several Sites

THE number of possible configurations of a mixture of molecules some occupying two sites, the remainder one site, was obtained by Chang[1]. The corresponding number for a mixture of molecules some occupying p sites, the remainder one site, was correctly stated by Miller[2] by analogy, but without proof. By using a technique considerably simpler than that used by these authors, I have been able to generalize these results to a mixture of any number of distinct types of molecules each with its own geometric properties.

Let the molecules of type i be N_i in number; let each such molecule occupy p_i sites; let the number of sites which are neighbours of one site be z; let the number of sites which are neighbours of a molecule of type i be $q_i z$; and let C_i denote the number of distinct configurations of a molecule of type i when one of its elements is fixed on a given site. The p_i's and q_i's are related by $z(p_i - q_i) = 2(p_i - 1)$.

The number of distinguishable arrangements $g(N_i)$ of this system is found to be given by

$$\begin{aligned}\log g(N_i) &= \tfrac{1}{2}z \log (\Sigma_i q_i N_i)\,! - \Sigma_i \log N_i\,! \\ &\quad -(\tfrac{1}{2}z - \;) \log (\Sigma_i p_i N_i)\,! - \Sigma_i N_i \log C_i.\end{aligned}$$

Details of the derivation of this formula and its use to derive thermodynamic properties will be published shortly.

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[1] Chang, *Proc. Camb. Phil. Soc.*, **35**, 265 (1939).
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Origin of the Solar System

THE criticisms of Alfvén's theory[1] of the origin of the solar system contained in Lieut.-Colonel Edgeworth's letter[2] seem to be based on a summary of the theory given by its author in an earlier letter[3]. This summary was clearly designed to illustrate the application of the theory to the newly discovered non-solar planetary systems, and it did not bring out what is perhaps the most attractive feature of the theory, namely, that it explains why a large part of the angular momentum of the solar system resides in the outer planets.

In a recent paper[4] Alfvén has shown that a cloud of ionized matter in the neighbourhood of a rotating magnetized conducting sphere is acted upon by electromagnetic forces which tend to make it take

part in the rotation. The sphere becomes electrically polarized due to its rotation, and a system of currents carried by charged particles moving in close spirals around the magnetic lines of force will flow between the ion cloud and the surface of the sphere. The interaction of these currents with the general magnetic field retards the rotation of the sphere and accelerates the cloud. The effect is thus an electromagnetic analogue of viscosity—with this difference, in the case of the solar system: that the mechanical forces involved are large enough to transfer a considerable part of the angular momentum of the sun to the cloud in a time of the order of 10^5 years. This transfer will begin to take place immediately after the ionization described in Alfvén's letter[3], and during the accumulation of the ions near the critical distance, which is identified with the distance of Jupiter. The planets and planetary satellites which afterwards condense from the cloud will, of course, retain the accrued angular momentum after formation.

It is interesting that this hypothesis not only accounts for the distribution of angular momentum among the members of the solar system, but also simultaneously explains the fact that the sun at the present time does not rotate as a whole. The detailed discussion shows that the electromagnetic retardation is greatest at high heliographic latitudes, and it is, of course, well known that the sun rotates more slowly near its poles than at its equator.

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Total Colour Blindness of Hysterical Origin

A CAPABLE and energetic motor mechanic and lorry driver aged thirty woke up one morning unable to remember who he was or his recent doings, or to recognize his wife or objects about him.

Before the breakdown he had been totally colour blind: red, yellow, green and blue lights looked white to him. After the breakdown, he was able to name and distinguish some colours of flowers and rug wools. During treatment he was tested at intervals with the Edridge-Green Beads, the Ishihara Test, Stilling's Tables and with the eight Ilford Spectrum Colour Filters and magenta. During six weeks of recovery from the amnesia, his colour vision gradually disappeared again, and he came to see all the colour filters as white, and divided the beads into 'white' (light colours) and 'black' (dark colours). Colours became dazzling and painful to his eyes, although he could not distinguish them. Meantime his normal memories slowly returned.

He was hypnotized by Dr. K. M. Abenheimer and given suggestions that he would be able to see all colours both then and after the trance. Tests during the somnambulic state and after it was over proved him to be an ordinary photerythrous red-green blind. His brother was found to have the same type of colour blindness, and his mother, father and two sisters showed small colour weaknesses.

Under hypnosis he re-lived the scene when he first became afraid of seeing colours. At the age of six he had a sore throat and his mother wrapped a multicoloured scarf round his neck. Later, when lying in his cot, he felt it choking him and cried out to have it removed. After this he had become afraid of the colours in the scarf and lost the ability to see them and all other colours.

He showed a strong emotional identification with his father in many ways, especially in liking hard work, and as a boy he had thought of colour vision as the opposite of his father, who was a coal miner and "could not see colours in the dark". Thus the total colour blindness made him like his father, according to a child's ideas, and saved him from a childish fear of his mother at the same time. It may have been chosen unconsciously as the basis of the child's hysterical reaction against his mother and towards his father because of sensitivity to the existing red-green defect. The amnesia was precipitated by a violent quarrel with a fellow lorry driver who had irritated him by being lazy on a busy day. It was like a childish outburst against his father's influence, and it started a period of amnesia with regression towards his dependence on his mother in early childhood. With this regression his partial colour vision returned, but disappeared again as the regression passed away, and was recovered under hypnosis.

I am indebted to Dr. Angus McNiven, Dr. K. M. Abenheimer and Mr. G. H. Haydock for their help, and to the patient and his wife for their co-operation.

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Grassland Improvement

THE Aberystwyth experiments, devised by Sir George Stapledon, on mechanical deep ploughing and reseeding with selected species and strains of grasses, have brought grassland management into line with arable-land experiences and have achieved considerable improvement in ley farming and hill pastures.

Recent exploratory work on rough pasture, moorland[1] and bracken-land[2] has shown that further progress is possible in this direction. The treatment of the area under investigation with calcium cyanamide (10 lb. per rod) and manganous sulphate (4 oz. per rod) during autumn, followed in the spring by reseeding with selected grasses in presence of soil containing nodule bacteria, adds new important features to grassland development. Thus we find that: (1) this method is applicable to areas where a steep gradient or shallow soil based on uneven rock (or clay) makes tillage impracticable; (2) the addition of lime and extensive humification favour the retention of moisture and the formation of a slimy surface, thus making the soil suitable for reseeding without ploughing; (3) calcium and nitrogen are added in a form and quantity corresponding to a long- and short-term fertilizer, benefiting both light and heavy soil (with the introduction of phosphorus and potassium when necessary); (4) parasiticidal activity and rapid humification add considerably to the fertility of the soil by their combined action upon the flora and fauna; (5) during this treatment the nitrogen-fixing and nitrifying bacteria are regenerated. Nitrification, nitrate and trace element (Cu) assimilation are also catalysed by the manganous sulphate[3], which as an anti-chlorotic agent[4] participates in the chlorophyll metabolism, and (6) the loss of nitrogen, accompanying the nitrous acid reactions in the soil, is greatly reduced by the carbohydrates abundant in the humifying bracken rhizomes[5].

The development of the Highland hydro-electric

scheme should make calcium cyanamide readily available in Great Britain, and the destructive action of this material upon parasites, ranging from viruses and fungi to wireworms, leather jackets, etc., should provide an important problem for parasitology.

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Origin of Indo-European Languages

PROF. ALEXANDER JÓHANNESSON, whose article appeared in NATURE of February 5, is, I believe, the first philologist of high academic standing who has systematically studied the sounds of speech from the point of view of the gestures of articulation which produce them, and has thus discovered for himself the pantomimic structure of human speech. His conclusions coincide generally with my own, which were originally drawn from the acoustic study of speech sounds.

There are, however, a few items in Prof. Jóhannesson's statement which seem open to question. He considers the Indo-European *R* sound as "originally cacuminal, hard and vibrating". I would have suggested that the Indo-European *R* was more probably produced by a backward curvature of the tongue tip, so as to produce a sound like the Wessex 'burr'. Its pantomimic meaning would be to bend or bend back, surround, cover, draw back, as in rake (heap up), ramp, rape, rim, ring, rend, ream, rib, reef, reel, rest, roost, rick, ride, rig (bind), rob, roll, roof, room, rope, round, rug, rump.

As to the vowels: *E* (as in men) is the result of a mid-height tongue posture; the pointing at oneself in ego is, I suggest, due to the *EG* gesture. I do not think that *EU* represents a 'circulating movement'; it is rather a forward movement (*U*) at mid-height (*E*).

Prof. Jóhannesson considers *S* as primarily an imitation of sounds in Nature. I would suggest that the *S* gesture generally denotes extension to a fine point or edge or limit. Thus, *SK* denotes extension from a forward point (*S*) to a backward point of closure (*K*); hence, skin, skim, skein, skid, scalp, skull (with hollow *U*), scoop. *SL* denotes sliding back or down: for example, slant, slip, slide, sleek, sleep, slope, slum, slump. *SM* denotes a sliding action towards a forward (lip) closure *M*, as in smear, small, smooth. *SN* is an in-drawing gesture, commonly associated with in-breathing through the nostrils, as in sneeze, snore, snout; or an inward or upward movement, as in snug, snag (projecting point). *SP* denotes drawing to a terminal point or fine edge, as in spear, spire, spout, spit, spade, spoon, spur, and asp, wasp, wisp. *STR* represents an elongated fore and aft movement, as in strong (extended hand drawn up towards the shoulder and terminating with a clenching of the fist), straight, stream, string, strand, strake (of timber), stretch, etc. *SW* is a forward motion, as in swell, swim, swift, swirl, swoop, swoon.

As to the symbolism of abstract ideas, I would suggest that in speech—as in sign language—the original meanings of all gestures have been concrete, and that the corresponding abstract interpretations have come later. It was the poetical faculty in man that enabled him to express his hitherto inexpressible sensations by concrete gestures, so that a shrinking gesture such as that of fear, fright, could be used to express the inclination to shrink, or the full-mouthed gesture 'good' to represent anything that was felt to be satisfying.

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Two of Prof. Jóhannesson's works—his "Grammatik der urnordischen Runeninschriften" and his "Islenzk tunga í fornöld"—are well-established handbooks for the Germanic philologist. But, in his recent article in NATURE[1] (and more fully in the Icelandic work to which he there refers), he has embarked for more unconventional regions. There is, in fact, no doubt that Prof. Jóhannesson has contravened that ancient and famous minute of the Société de Linguistique which prohibited discussion of the origin of language. There was—and always will be—a sound basis for that excellent minute, and for a simple reason. In all languages known to us—whether ancient (like Sumerian) or modern (like modern English)—we observe that, for the great majority of words, the connexion between sound and sense is random; thus there is no reason known to us why, in English, the word for "7" should begin with *s* and that for "10" with *t* rather than vice versa. We may suppose that, in the very distant epoch when language originated, either the sound-sense relation was random or it was not. But the linguistic changes which must have operated in the long period intervening would certainly have quickly reduced a non-random sound-sense relation to a random one, similar to that which we have in known languages.

Therefore to accept Prof. Jóhannesson's theory is to disbelieve in the heterogenizing effect of continuous linguistic change, and to do this would be to go against all that we know of language. There is implicit in Prof. Jóhannesson's views the suggestion that reconstructed Indo-European preserves an original non-random sound-sense relationship (cf. his remark in para. 4: "The roots beginning with dentals have a similar meaning, as the first man either pressed his teeth together . . ."). Reconstructed Indo-European is usually attributed to the third millennium B.C. and was presumably the language of a people at a fairly high level of civilization; thus long vistas of masking sound-change must separate its dentals from the original state of affairs envisaged by Prof. Jóhannesson.

Two special points call for comment. In his third paragraph Prof. Jóhannesson offers some discussion of ablaut; it is, at the least, remiss of him not to have taken cognizance of the views of Kuryłowicz, who succeeded, in the years before the War, in tracing the history of the Indo-European vowels to an earlier stage than had been reached up to that time. On p. 172 Prof. Jóhannesson says that "Philology must become a scientific study". To most philologists the question whether philology is a science or an art will scarcely seem important, but admirers of the great masters of scientific philology—Brugmann, de Saussure and, above all, Meillet—will find it hard to condone the implication that these men were at fault in their method.

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[1] NATURE, **153**, 171 (1944).

RESEARCH ITEMS

Transfusion into the Bone Marrow

WORKERS who are studying the intravenous administration of blood and other fluids will be interested in the method of delivering such parenteral fluids into the manubrium of the sternum which is described by Mr. Hamilton Bailey, of the Royal Northern Hospital, London (*Brit. Med. J.*, 181; Feb. 5, 1944). Referring to the work of L. M. Tocantins and J. F. O'Neill (*Surg. Gynæc. Obstetr.*, 73, 281; 1941), Mr. Bailey says that he considers the manubrium as good a receptor as a vein for infusions of all kinds and for pentothal anæsthesia. After local anæsthesia with novocain, a special trochar is introduced between the two plates of the manubrium, the depth to which it penetrates being controlled by two wings on the instrument. To make sure that the bone marrow has been reached and to avoid such possible accidents as the injection of the fluids into the superior mediastinum, sodium citrate is first injected with a syringe fixed to the cannula. If this syringe then withdraws bone marrow, which looks like blood, easily and liberally, it is known that the cannula is in the bone marrow. It is then quickly linked to the transfusion apparatus. A possible danger is the production of osteomyelitis, but this has not occurred in Mr. Bailey's sixty cases. Whole blood cannot be introduced as rapidly as it can be given into a vein by gravity, but this difficulty is being overcome. Advantages of the method are that it is relatively painless, that thrombosis or phlebitis cannot occur, and that the apparatus is on the sternum and so is out of the way of the surgeon during operations and can be controlled by the anæsthetist. The method is also free from the difficulty, which is often considerable, of getting a cannula into the veins of severely shocked patients, whose veins may be also so severely collapsed that satisfactory reception of the parenteral fluid is difficult; in dehydrated infants the method is certain and safe. It can, moreover, be carried out in a poor light, so that fluids can be given more easily and quickly under black-out conditions.

Inheritance of Awn Barbing in Wheat

THE beards or awns of wheats are normally rough, due to short, thick-walled, unicellular hairs with fine points which are directed towards the tip. Among 'smooth'-awned durum wheat selections, it has been found that two different, true-breeding types may be distinguished (P. F. Knowles, *Canad. J. Res.*, 21, C 198; 1943). In the first type, termed 'smooth', the upper half of the awn is free from barbs and the lower half very slightly scabrous, increasing in intensity towards the base of the awn. In the second or 'intermediate' type, barbs are found from the tip to the base of the awn, but in the upper part they are few in number and reduced in size, whereas in the lower portion they are very numerous and intermediate in character between the 'smooth' and the normal 'rough' types. The types are shown to be due to the expression of two pairs of alleles, designated *Rr* and *Ss*. *RRSS*, *RRSs*, *RrSs*, *Rrss*, etc., are 'rough'-awned, *rrSS* is 'intermediate', *rrSs* is a non-true breeding 'near-smooth' and *rrss* is the true-breeding 'smooth'-awned type. The segregations obtained for the characters of glume colour, glume pubescence and awn colour, showed that the inheritance of each is determined by the action of one pair of factors, that glume pubescence is linked with awn colour and that the inheritance of all these is independent of awn barbing. It is a pity that the symbols R and S have been used in accordance with the notation first used for barley but now discarded for that species: R is usually reserved for the three grain-colour factors and S has been used for the spring habit. Furthermore, the smooth-awned gene originally designated S in barley is a dominant.

Physiology of Incompatibility in Plants

IN the third paper of this series, D. Lewis (*J. Genetics*, 45, 171; 1943) describes his investigations on incompatibility in autotetraploids. It will be remembered that in diploids a style carrying S_AS_B will inhibit the growth of either S_A or S_B pollen grains. In tetraploids there are complications such as the pollination of $S_AS_CS_CS_D$ by S_AS_B pollen. Using synthesized tetraploids of *Œnothera organensis*, the author has investigated this and similar phenomena. Pollen heterozygous for different S factors can be shown to differ by their reaction to temperature and growth. The fact that a pollen tube carrying an incompatible and a compatible gene in relation to those of the style show different reactions according to the specific genes involved indicates that competition is taking place for some substance. The author suggests the similarity between incompatibility in plants and the phenomena of antigens and antibodies in animals. The effects of incompatibility upon survival of tetraploids and economic selection are discussed.

Effects of Banana Selection

K. G. DODDS (*J. Genetics*, 45, 113; 1943) has examined the cytology of some diploid parthenocarpic bananas. Three of the five examined are structural hybrids, a fourth shows little bivalent formation while the fifth exhibits a single reciprocal translocation. Parthenocarpy and sterility of the female flowers is genetic in origin. The author shows that parthenocarpy and female sterility arose by gene-mutants in fertile diploids; the resulting edible types were taken into cultivation and propagated by clones. By selection, and in course of time, parthenocarpy became established, and with the absence of selective control on the sexual process the evolution of structural hybridity took place. This was favoured probably by the selection of more sterile forms. Hence male sterility was added to female sterility. Later, polyploidy arose, but this is considered to be of less importance in the evolution. Possibly the larger size of polyploids may have attracted the early selectors.

Electric Polarizations in Extremely Dilute Solutions

THE abnormal behaviour sometimes found in the polarization curves at high dilutions on plotting polarizations against mol fractions has been supported by some investigators and denied by others. R. Davis, H. S. Bridge and W. J. Svirbely (*J. Amer. Chem. Soc.*, 65, 857; 1943) have made some measurements in benzene and dioxane solutions and computed the molecular polarizations by Hoecker's method. This involves plotting the product of polarization and mol fraction of the solute P_2N_2 against N_2 and taking the slope of the resulting line as P_∞. This will be equal to P_∞ only if P_2 is constant. Large-scale plots showed that the P_2N_2 against N_2 plot was linear under proper conditions, and the conclusion was reached that the

abnormal behaviour in polarization curves encountered in very dilute solutions is due to experimental error in measuring P_1 and has no physical significance.

Solubility of Silver in Mercury

AN interesting study of the solubility of silver in mercury has been published by D. R. Hudson (*Metallurgia*, Sept. 1943). The author has determined the solubility over a range of temperatures up to 450° C., the materials being sealed in a glass bulb. The measurements, combined with those of previous workers, with which they are consistent, afford information extending over a temperature range exceeding 950° C. Measurements quoted in the highest range up to the melting point of silver were made by Murphy using the usual metallurgical methods. The existence of the peritectic temperatures of formation of Ag_5Hg_4 and Ag_5Hg_8 produces no noticeable effects on the graph of log N_{Ag} plotted against $1/T$ (where N_{Ag} represents the molecular fraction of silver in the saturated liquid solution, and T represents the absolute temperature). At two other temperatures, however, sudden changes of slope of the graph occur, and may be roughly predicted from purely physical properties of silver and mercury by using an equation due to Hildebrand. The equation may be modified so as to allow for the solid solubility of mercury in silver, and in this way a somewhat closer approximation to the experimental determinations can be obtained. Although the equations used by Dr. Hudson exhibit the main features of the experimental determinations, the shape of the liquidus curve of a binary metallic system cannot in general be closely predicted from a knowledge of relevant physical properties of the pure components.

Carbon Monoxide 'Cool Flame'

AT a temperature just below the ignition point, a mixture of carbon monoxide and oxygen shows a pre-ignition glow or 'cool flame', the spectrum of which has been studied by A. G. Gaydon (*Proc. Roy. Soc.*, A, 182, 199; 1943). Photographs were got of the spectra with carbon monoxide and oxygen or nitrous oxide. The cool flame shows the same faintly banded spectrum as the normal flame. but this band structure is more clearly developed. The OH bands are absent from the cool flame, which, however, shows strong sodium emission. Cuprous chloride appears very readily as an impurity, and the band systems of CuCl show a markedly different intensity distribution in the cool flames with oxygen and with nitrous oxide. The application of the results to the theory of the combustion mechanism is briefly discussed. The paper is the third in a series on the flame spectrum of carbon monoxide.

Electron Diffraction of Amorphous Polymers

WHEREAS some polymeric substances give characteristic crystalline diagrams under X-ray or electron diffraction examination, others show such diagrams only when stretched under suitable conditions of temperature. Normally, in their unstretched form they give an 'amorphous' pattern, retained in several cases even on stretching. Special attention has been given to 'amorphous' polymers by G. D. Coumoulos (*Proc. Roy. Soc.*, A, **182**, 166; 1943). The configurations of polyvinyl acetate and the acrylate and methacrylate polymers revealed by electron photographs suggest a zigzag carbon atom chain for the long main-chain, which has the 1,3 structure, with the side-chains alternately on the right and the left of the zigzag chains and on planes approximately perpendicular to the axis of the main chain. These side-chains are subject to lateral cohesive forces which group them in clusters. In the clusters, the side-chains tend to lie parallel to one another. In the lenses the clusters consist of a few side-chains showing no recognizable arrangement. The multi-layer pattern suggests a certain orientation of the side-chains with perhaps more grouping together. The patterns indicate an 'amorphous' character due to the close packing of the side-chains in clusters, producing distortion of the main-chain and preventing adlineation. On the basis of this configuration, some of the elastic properties of these polymers are discussed and a note is made on the occurrence of high elasticity.

Production of Penetrating Showers

L. Jánossy and G. D. Rochester have reported (*Proc. Roy. Soc.*, A, 182, 180; 1943) the results of an experimental study of the nature of the shower-producing radiation suggested by an earlier investigation by Jánossy. It is shown that about one third of the radiation producing penetrating showers is non-ionized and more penetrating than photons. The total intensity of this non-ionizing radiation, named N-radiation, is found to be about 0·001 per cent of the full cosmic radiation near sea-level. The N-radiation is possibly the energetic part of the penetrating non-ionizing component of cosmic radiation. It is suggested that this radiation consists of neutrons.

Direction of Rotation in Spiral Nebulæ

UNAMBIGUOUS determination of the direction of rotation of extra-galactic nebulæ with respect to their spiral pattern needs three data: the sense of the rotation, the sense of the spiral pattern and the sense of the tilt. The first can be obtained from spectrograms, the second from direct photographs, but there is still considerable controversy over the determination of tilt, which cannot be observed directly but must be inferred from observations which may be interpreted differently by different people. A recent paper by Edwin Hubble (*Astrophys. J.*, 97, 112; 1943) uses dissymmetry of obscuration with respect to the major axis as a criterion of tilt in fifteen spirals in which the arms can be traced. He finds that the arms are either all trailing or all leading the nuclei. In four critical cases, he claims, lanes of obscuration silhouetted against the nucleus show unambiguously which is the nearer side of the nebula; and applying this criterion of tilt, he finds that the arms are trailing. As a working hypothesis he therefore assumes that the arms trail in all spirals. In recent papers, however (*Stockholm Ann.*, **14**, Nos. 1, 3, 4; 1942), Lindblad and Ohman come to the opposite conclusion by assuming that the dark matter is distributed more or less uniformly through the nuclear region. The heavier obscuration should then occur on the farther side of the nucleus, where the light rays are absorbed most. Unfortunately, in the one case where the Swedish school agrees with the American as regards the direction of tilt, they disagree on the sense of the spiral pattern. The matter is of great importance in discussing the evolution of spiral nebulæ, and further independent evidence is badly needed.

CHEMICAL STRUCTURE AND ANTI-FIBROMATOGENIC ACTIVITY OF STEROID HORMONES

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LIPSCHÜTZ and Iglesias[1] showed that subserous fibroids scattered in the abdominal cavity (gastric, splenic, mesenteric, uterine, parametric and fibroids of the abdominal wall) can be induced in female guinea pigs to which œstrogens have been administered for a sufficient length of time. These fibroids infiltrate into surrounding tissues, especially smooth and striated muscle. All œstrogens, natural or artificial, free or esterified, have been found to be fibromatogenic. Localization of these abdominal fibroids follows a certain pattern independent of the œstrogen used[2] (for summary, see ref. 3). In the course of our work we have also established that certain steroid hormones, when administered simultaneously with the fibromatogenic œstrogen, prevent formation of fibroids. Progesterone, desoxycorticosterone[4], dehydrocorticosterone[5] and testosterone[4] were shown to be antifibromatogenic. Fibroids which have already been induced by œstrogenic action begin to regress when about three months later an antifibromatogenic steroid (progesterone) is given and allowed to act simultaneously with the œstrogen[6,7].

All the four natural antifibromatogenic steroids mentioned were 3-keto-steroids with a double bond Δ^4 in ring I. Progesterone and seemingly also desoxycorticosterone were more active than testosterone, and it was assumed that the side chain of two carbons at C_{17} enhances antifibromatogenic action[8,9,10]. On the basis of these findings and assumptions, a systematic search for antifibromatogenic steroids was made among known artificial steroids with the purpose of relating antifibromatogenic activity with chemical structure. So far, a total of ten different artificial steroids, that is, steroids not occurring in the body, and some esters of these have been studied[11]. The results are summarized in the accompanying table.

Three artificial 3-keto-steroids were tried. Δ^{16}-dehydroprogesterone, which differs from progesterone by a double bond in ring IV, showed no antifibromatogenic power even when considerable quantities were used. The antifibromatogenic activity of testosterone is abolished by oxidation at C_{17}; Δ^4-androstene-3-17-dione failed to prevent fibroids even when huge quantities were absorbed. Prolongation of the side chain in position 17 also was detrimental: cholestenone was not antifibromatogenic.

Dihydrotestosterone lacking the double bond Δ^4 was found to be no less active than testosterone. On the basis of this finding, two compounds lacking the double bond Δ^4 but having the side chain at C_{17} like progesterone were tried; but both these artificial steroids, allo-pregnanedione prepared by Dr. K. Miescher from cholesterol and pregnanedione prepared by Dr. A. S. Cook from urine, were found to have no antifibromatogenic faculty.

All steroids, natural or artificial, having a hydroxyl group at C_3 failed to show antifibromatogenic activity, whether the side chain of two carbons at C_{17} was present (acetoxypregnenolone, substance *H* of Kendall) or not (androsterone, androstanediol, androstenediol).

As to the relation of antifibromatogenic action to the *physiological* activities of steroid compounds, the following statements can be made. All 3-keto-steroids which we found to be antifibromatogenic are known to be *progestational*, though in a varying degree; but all 3-keto-steroids which were found not to be antifibromatogenic, are not known to be progestational, with the possible exception of androstenedione. *Masculinizing* activity is not concomitant with the antifibromatogenic one, as shown by two different facts: there was no masculinization of the genital region in the guinea pig (transformation of the clitoris into a hypospadic penis) with antifibromatogenic quantities of progesterone, desoxycorticosterone and dehydrocorticosterone, whereas masculinizing quantities of androstenedione were not antifibromatogenic. Neither was there full parallelism between antifibromatogenic and *antiœstrogenic* activities. Though the vaginal opening closed often definitely under the influence of antifibromatogenic steroids, proliferation of the basal epithelium of the vaginal mucosa was not fully inhibited. The growth of the nipples and of the mammary glands was not inhibited but rather enhanced by antifibromatogenic steroids.

The statements referring to the correlation of the antifibromatogenic activity of steroids with their chemical structure and with certain physiological activities, conflicting as these statements are so far, may serve as important starting points for further experimental work in the field of research on antitumoral actions of steroid compounds, natural or artificial.

Our work with tumorigenic and antitumorigenic steroids was aided by grants from the Rockefeller Foundation and the Jane Coffin Childs Memorial Fund for Medical Research. It was greatly furthered by the application of the ingenious technique of subcutaneous implantation of steroid tablets advised by Drs. R. Deanesly and A. S. Parkes[12]. Thanks are due for steroids to Dr. E. C. Kendall of the

	Antifibromatogenic (3-keto-steroids)	Not antifibromatogenic (3-keto-steroids)	Not antifibromatogenic (OH at C_3)
Occurring in the body	With Δ^4: progesterone (15)*; desoxycorticosterone (90); dehydrocorticosterone (100); testosterone (200 ?)		androsterone [240]
Not occurring in the body	Without Δ^4: dihydrotestosterone (110 ?)	With Δ^4: Δ^{16}-dehydroprogesterone [160]†; androstene-3, 17-dione [570]; cholestenone [160]; Without Δ^4: allo-pregnanedione [150]; pregnanedione [260]	androstane-3, 17-diol [220]; Δ^5-androstene-3, 17-diol [175]; Δ^5-acetoxypregnene-3-ol-20-one [320]; Kendall's compd. *H*. (17-ethyl-androstane-3, 21-diol-11,20-dione [160]

* Figures—subject to rectification—in brackets ( ) indicate the antifibromatogenic threshold or the *minimum* quantity (in µgm.) absorbed per day which was still *sufficient* to prevent production of abdominal fibroids in about 80 per cent of animals.

† Figures in brackets [ ] indicate the *maximum* quantity (in µgm.) absorbed per day which was *insufficient* to prevent production of abdominal fibroids.

Mayo Clinic, Rochester, Minn.; to Dr. Karl Miescher of Ciba, Basle; to Dr. E. Oppenheimer of Ciba Pharmaceutical Products, Summit, N.J.; to Dr. A. S. Cook of Ayerst, McKenna and Harrison, Montreal; to Dr. E. Schwenk of Schering Corporation, Bloomfield, N.J.; to Dr. M. Tausk of Organon, Holland; to Dr. O. Kamm of Parke, Davis and Co., Detroit; to Dr. F. Giral of Laboratorios Hormona and Instituto Politécnico, Mexico.

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[8] Lipschütz, A., *Rev. Med y Alim.* (Chile), 5, 73 (1941).
[9] Lipschutz, A., Vera, O., and González, S., *Cancer Res.*, 2, 204 (1942).
[10] Lipschütz, A., *Rev. Canad de Biol.*, 2, 92 (1943).
[11] Unpublished work in collaboration with Drs. S. Bruzzone, F Fuenzalida, R. Iglesias and others.

THE PULSATION THEORY OF CEPHEID VARIABLES

PROF. SVEIN ROSSELAND delivered the George Darwin Lecture of the Royal Astronomical Society, on September 10, 1943, on "The Pulsation Theory of Cepheid Variables", and the address is now available (*Mon. Not. Roy. Astro. Soc.*, 103, 5; 1943).

In the introduction, Prof. Rosseland refers to different types of stellar motions, the simplest type of large-scale motion being rotation round a fixed axis; this particular problem must be considered to be still in a preliminary stage both from the theoretical and observational points of view. The expansion and contraction of a star as a whole is a second type of large-scale motion, and this can be said to be represented in the sun by the outward motion of the corona; but it is most conspicuous in Wolf-Rayet stars and novæ, where direct observation of the expansion is possible. In the case of Cepheids and other periodic variable stars, it is believed that a *periodic* type of expansion and contraction is at the root of the phenomena.

The problem of interpreting the behaviour of Cepheid variables was responsible for the idea that stars may perform spherical pulsations, and it is interesting to notice that Coodricke, who announced the variability of δ Cephei in 1783, was cautious enough not to attribute its variability to eclipses in a binary system, like β Persei. It was not until 1879 that August Ritter developed a rudimentary theory of the pulsation hypothesis and suggested that Cepheids might owe their light-variation to pulsation. He made the important discovery that the slowest mode of pulsation of a homogeneous star has a period inversely proportional to the square root of its density, and also found that this mode of pulsation becomes unstable when the ratio of specific heats falls below 4/3—a result which holds, not only for the Cepheids, but for other gaseous stars as well. Unfortunately, Ritter's suggestion received little attention, and in 1894, when Belopolsky discovered the periodic variation in the position of the lines in the spectrum of δ Cephei, this fact was interpreted as a confirmation of the binary star theory of Cepheids.

Plummer was the first to show that the binary hypothesis was very doubtful, and in the following year, 1914, Shapley ruled out the hypothesis by an analysis of observational data, suggesting the pulsation hypothesis as an alternative. His most convincing argument was that if a companion to a Cepheid were responsible for the light-variation, the size of the orbit would be so small that the companion would necessarily move well inside its primary. Eddington took up the subject of the pulsating hypothesis in 1917–18 and raised it to the rank of a mathematical theory in which quantitative issues are involved. A few observational facts about Cepheids were definitely established by that time; thus the periods, the general form of the light-curve, the velocity-curve, and the period-luminosity relation were known. More information is now available on the correlation between the period and the mean density, enabling a preliminary check to be made on the theoretical law, and in addition, much more material can be utilized concerning the form of the light- and velocity-curves.

The problem of the pulsation theory is beset with many difficulties, and it has been found necessary to approach it in successive steps. In the first step, the theory was developed within the framework of ordinary acoustics, and in this case wave motions are linearly superposed to form compound waves, the oscillations being assumed adiabatic. Within the acoustic limit the relation

$$P\sqrt{\rho} = K$$

holds, where P is the period and ρ the mean density, K being a constant for each stellar model, but differing for different models. When $\log P$ is plotted against $\log \rho$, the plot should reduce to a straight line forming an angle of 45° with the axis, for stars of the same model, and stars of the short-period and Cepheid type fall very closely along a line which is parallel to this line, but well to the right of it, thus confirming theoretical expectations. The long-period stars fall widely off the line, still farther to the right, and the only group that conforms to expectations is the small group of short-period variables in Messier 3, discovered by Schwarzschild. Two possible ways of overcoming the difficulty are suggested. If it is admitted that different groups of stars have different values of the ratio of specific heats, a drop from 1·6 to 1·4 would suffice to bring the theoretical line into coincidence with the observed Cepheid line, but a considerably greater alteration would be necessary to bring the theoretical line into coincidence with the observed long-period line. No physical basis exists for such an assumption regarding the alteration in the specific heats ratio. Another suggestion is that the stellar model should be altered so that the central density would be 10 times instead of 54 times the mean density, but even such a drastic alteration would not explain the position of the long-period variables in the diagram.

After discussing these difficulties, Prof. Rosseland deals with his own work, in which the acoustic approximation is abandoned. In the case of an ordinary pendulum, infinitely small oscillations are sinusoidal, and the period is independent of the amplitude, like small oscillations of a star. When the swings of a pendulum increase, the oscillations cease to be sinuosidal and are represented by elliptic functions, the period increasing at the same time. If a curve is plotted giving velocity against time, the change in its shape enables us to infer the length of the period, and we might expect, in a general way, that the

same situation holds for the pulsations of a star. As the velocity curve differs more and more from a simple sine curve, so the period may be expected to lengthen relative to the period computed from the elementary theory. Eddington dealt with the subject of an extended pulsation theory in 1918, and showed that theory predicts a faster rise of the velocity to a maximum than the subsequent drop to a minimum, and in 1937 Miss Kluyver extended the investigation to include a dependence of period on amplitude. Prof. Rosseland develops his theory of 'anharmonic pulsations' in an appendix, and finds that the semi-amplitude of oscillation would have to be a quarter of the radius of the star—a value 4–5 times too great for most of the Cepheids. He admits that there is a considerable discrepancy to bridge, and it does not appear that this can be done by varying the model. It can probably be done if the calculations are extended to include more coupling terms in the equations.

In conclusion, Prof. Rosseland points out the incompleteness of the pulsation theory in its present stage, and even the 'anharmonic theory' must still be considered to be in its infancy. As already pointed out earlier in this summary, there is a problem connected with the separation of the Cepheids, long-period variables and the $M3$ group, and no solution has yet been attained. It is suggested that inherent physical differences between the stars of these three groups exist. Regarding the phase retardation of luminosity, the pulsation theory has little to say, though it is admitted that Eddington's suggestion about the hydrogen convection zone may finally lead to a solution of this problem. In this connexion further work on the anharmonic pulsations may be important, and the same applies to the period-luminosity law, an interpretation of which has not yet been afforded. The fact that the pulsation theory has survived for nearly thirty years against hard tests is an indication of the soundness of its basic assumptions, and it will remain a fruitful field of work in the future development of astrophysics.

NATIONAL RESEARCH COUNCIL OF CANADA

THE annual report of the National Research Council of Canada*, 1941–42, includes the report of the president, the financial statement for the fiscal year 1941–42, as well as the reports of the directors of the various divisions, the Gauge Measurement Laboratory, the Radio Board, the Section on Codes and Specifications and the Research Plans and Publications Section. Practically all the activities of the National Research Council in 1941 were directed to the study and solution of problems immediately connected with Canada's growing war effort, and the Council has been officially designated as the Research Station of the Royal Canadian Navy, the Army and the Air Force, and is shown as a civil establishment in the records of the Department of National Defence.

The Divisions of Chemistry and of Applied Biology have been engaged largely in selecting and testing suitable materials for the use of the armed forces, and in the Physics, Electrical and Mechanical Engineering Departments, the design and development of new detecting devices to locate aircraft, submarines, mines, and other enemy equipment have been carried forward with much success. Engines, aircraft and other items of equipment used in mechanized warfare have been tested on a large scale, and additional staff and facilities have been provided to meet the new requirements, the staff of the Council working in the Ottawa area numbering 803 on March 31, 1942, as against 308 in July 1939, the greatest increase in numbers being in the Division of Physics and Electrical Engineering. New buildings have been constructed to house the aeronautical and hydraulic laboratories and the work of some of the other divisions. A radio field station has been established near Ottawa, and owing to the large increase in the staff of the radio section, a Radio Board has been established for the general direction of all radio research and development work in connexion with the Council's war activities. An important war service has been rendered by promoting the development in Canada of optical glass manufacture for precise optical parts of military equipment.

The Division of Biology and Agriculture, which has been renamed the Division of Applied Biology, has devised methods for converting large insulated cargo holds into refrigerating space without delaying the vessel to provide an immediate solution for the acute bacon transport problem, and a standard curing practice has been developed in Canadian package plants which yields a more stable product. Other work in progress in this Division relates to the treatment of shell eggs to prevent deterioration during shipment at ordinary temperatures, tests on the quality of dried eggs and the preparation of specifications for shipping, investigations on drying pork, canning poultry, vitamin content of flour and the development of rapid growing, easily propagated forest trees; vegetative propagation has reached the stage when cuttings of Norway spruce, white spruce and white pine can be successfully rooted on a practical scale.

In the Division of Chemistry, the Plastics Laboratory of the Colloidal Section, which was being equipped at the outbreak of war, has carried out a survey and experimental work on the use of laminated wood in aircraft construction in co-operation with the Division of Mechanical Engineering. In the physical chemistry section investigations on the development of de-icing fluids, prevention of frost deposition on aircraft, resolution of aerial photographs, etc., have continued, while the organic chemistry section has continued its general programme of research on alkaloids and has synthesized indicators for war gases and chemicals for other war purposes; in the preparation of some special organic chemicals, production has been advanced to semi-pilot plant scale. In addition to investigating products used by almost every branch of the armed forces, including surgeons' gloves, ground sheets, gas-mask components, etc., the rubber laboratory has given much attention to rubber conservation problems and to the study of processes for synthetic rubbers. The refractories laboratory continued its investigations of high-temperature furnace linings. Experiments on the production of metallic magnesium have been pushed forward until a process worked out in the laboratory has been sponsored in a more detailed study embodying pilot-plant operation by a group of industrialists.

Activities in the textile laboratory were largely devoted to acceptance test work and specifications. An explosives laboratory was established late in 1941 to carry out testing under the Explosives Act and conduct research on explosives and related compounds.

* Twenty-fifth Annual Report of the National Research Council of Canada, 1941–42. (N.R.C. No. 1089.) Pp. 33. (Ottawa.)

Under war-time conditions, the demand for searches of scientific literature in planning laboratory research have increased; research workers in all fields of science have made increasing demands on the trained personnel of the Council staff who prepare bibliographies and abstracts or digests of the literature. Although ten of the Council's numerous associate committees have been disbanded and others will remain inactive until after the War, many new committees have been established to give advice or organize and direct research on important problems, in addition to the twenty-eight associate committees of the Council in existence at the end of the year. Special reference is made in the report to the associate committees on medical research and on aviation medical research. Subjects selected for investigation by these sub-committees have included problems in fatigue, vision, hearing and related subjects, wound infection studies, including work in chemotherapy, treatment of shock, development and provision of blood substitutes for transfusion purposes, treatment of burns and other war injuries, dietary studies, problems involved in high-altitude flying and the improvement of oxygen breathing-systems, and protective clothing to counteract effects of cold, fatigue and high accelerations.

The Council has also been particularly active in maintaining the most effective liaison possible in the scientific work going on in Great Britain, Canada and the United States.

SEAWEED PRODUCTS IN AUSTRALIA

By E. J. FERGUSON WOOD and VALERIE MAY JONES

Fisheries Div., Council for Scientific and Industrial Research, Australia

PRIOR to 1940, little had been done in Australia to develop any industries using seaweeds as the raw material. In the last century, a company was formed to make agar from the red alga, *Eucheuma speciosum* (Sond), J.Ag. at Dongarra in Western Australia; potash was produced from Macrocystis and Ecklonia in Tasmania during the War of 1914–18, and several attempts were made at different times to utilize the fibres of *Posidonia australia* Hook. F., which is prolific in South Australian waters and elsewhere. With the death of each of these schemes, seaweed research for industrial purposes languished, and even taxonomy was so neglected that for some years prior to his death, A. H. S. Lucas was the only person in Australia working with the marine algæ of the Continent.

The need for agar in Australia stimulated seaweed research, and the discovery of a quantity of *Gracilaria confervoides* (L.) Grev. at Bateman's Bay and Botany Bay in New South Wales revived interest in the Rhodophyceæ. Studies on the method of production of agar from Gracilaria, carried out at the laboratory of the Fisheries Division of the Council for Scientific and Industrial Research, have culminated in the undertaking of agar production by a Sydney firm. *Gracilaria confervoides* is known to occur in large beds in shallow water in a number of areas in New South Wales and southern Queensland, and is very easily harvested and dried. It is estimated that there will be sufficient raw material in New South Wales to produce at least 100 tons of agar per year, even allowing for fluctuations in the growth of the seaweed. Gracilaria has been found along the coast from Tuross Lake in New South Wales to Urangan in Queensland, a distance of 850 miles. It occurs on shallow flats, in lagoons, estuaries and bays, where conditions are favourable. There is a seasonal rhythm in its abundance, though it appears that this may vary in some seasons. The spores appear to adhere often to shellfish (usually whelks, sometimes cockles and mussels) or to a polychæte worm cast (Eunice), and occasionally to sticks, rocks, etc. Experiments are being made with a view to the cultivation of Gracilaria.

The seaweed is harvested by special grapnels or, in very shallow water, by hand, then loaded into dinghies and taken ashore and dried on wire-netting racks. When dry, it is pressed into bales, and is ready for the manufacturer.

The cardinal features of manufacture are boiling with live steam in open vats, and keeping the pH below 7 and preferably below 6·5, but above 5·0. Owing to the difficulty of procuring the necessary materials, the agar has been made in iron or copper equipment, and this results in discoloration and in a high ash residue. Efforts are being made to overcome this. Gracilaria agar tends to be viscous and to have a high setting point, but these are no detriment in the food industries. For bacteriological purposes, Jensen has shown that although these qualities are a disadvantage for poured plates, slopes made from Gracilaria agar will grow most organisms as well as, if not better than, the slopes made from Japanese agar. Two British bacteriologists have also expressed satisfaction with Gracilaria agar in private communications to one of us.

Agar is also manufactured in Western Australia from *Eucheuma speciosum*, which appears to grow in quantity on reefs in the Dongarra district, and to some extent elsewhere. Detailed surveys of these beds are projected. The agar is more easily extracted from Eucheuma than from Gracilaria, but collection of the seaweed from reefs will prove more difficult. This agar also is used for meat canning, and has the same disadvantages for bacteriological purposes as Gracilaria agar.

Hypnea musciformis (Wulf) Lam. is moderately widespread in occurrence, though not occurring in large quantities in any one part of Australia. It makes a very good bacteriological agar with a low viscosity and setting point. It is not used commercially so far.

At the present time, Australian agar production is far below local requirements, but there appears to be no technical reason why these requirements should not be met within the next twelve months, and there is every indication that the raw material will prove adequate.

The production of alginates, potash and iodine have been studied also, and alginates of excellent quality can be prepared from Ecklonia from New South Wales, or from Macrocystis from Tasmania. Abundant growth of Macrocystis occurs in southern Tasmania, which would be the logical centre of the industry. Unless produced as a sideline from an alginate plant, potash and iodine production could be made payable only in war-time. No commercial production of these substances has yet begun.

The commercial development of agar has stimulated systematic and distributional studies of the Rhodophyceæ, and this work is progressing steadily.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public.)*

Saturday, February 26

SCHOOL NATURE STUDY UNION (at the Central Club, Y.W.C.A., Great Russell Street, London, W.C.1), at 2.30 p.m.—Thirty-eighth Annual Conference; at 3 p.m.—Prof. W. B. R. King: "The Evidence of Fossils".

Monday, February 28

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. E. B. Bailey, F.R.S.: "Natural Resources of Great Britain", 2: "Underground Water". (Cantor Lectures, 2.)

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (joint meeting with the ASSOCIATION OF TAR DISTILLERS) (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 2.30 p.m.—Dr. H. Levinstein and Mr. J. Idris Jones: "Plastics and the Coal-Tar Industry".

BRITISH ASSOCIATION OF CHEMISTS (NORTH-EAST SECTION) (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.30 p.m.—Prof. J. B. Speakman: "Protein Fibres, their Reactivity and Industrial Application" (Fifty-fourth Bedson Lecture).

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at Austria House, 28 Bryanston Square, London, W.2), at 7.15 p.m.—Mr. N. J. Radinger: "Rust, Acid and Heat Resisting Steels" (in German).

Tuesday, February 29

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Clyde Higgs: "Mechanisation of the Mixed Farm".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (joint meeting with the PHYSICAL SOCIETY OF MANCHESTER and the GEOGRAPHICAL ASSOCIATION) (at the University, Manchester), at 5 p.m.—Dr. E. C. Bullard: "Geological Time".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Dr. J. Ramsbottom: "Fungi and Modern Affairs", 3. "Fungi in Harness".*

INSTITUTION OF CIVIL ENGINEERS (STRUCTURAL AND BUILDING ENGINEERING DIVISION) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Miss Letitia Chitty: "Modern Experimental Methods in connexion with the Design of Statically Indeterminate Structures".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 6.30 p.m.—Mr. J. C. Gregory: "The Technique of Metallographic Examination".

Wednesday, March 1

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—The Rt. Hon. the Earl De La Warr: "Flax Production in War, and its Prospects in Peace".

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. A. J. Maddock: "Some Applications of Thiratrons in Radio Engineering".

INSTITUTE OF WELDING (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Mr. W. K. B. Marshall: "Recent Developments in the Welding of Light Metals".

Thursday, March 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Jack Drummond: "Food Fads and Food Fallacies".*

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (in the Reid-Knox Hall, British Institute of Radiology, 32 Welbeck Street, London, W.1), at 5.30 p.m.—Dr. F. C. Toy: "Electron Microscope".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. A. E. W. Austen and Miss W. Hackett: "Internal Discharges in Dielectrics, their Observation and Analysis".

CHEMICAL SOCIETY (LEEDS AREA LOCAL SECTION) (joint meeting with the LEEDS UNIVERSITY CHEMICAL SOCIETY) (in the Chemistry Lecture Theatre, The University, Leeds), at 5.30 p.m.—Discussion on "The Mechanism of Oxidation-Reduction Reactions" (to be opened by Prof. H. S. Raper, F.R.S., Prof. M. G. Evans and Dr. W. A. Waters).

Friday, March 3

PHYSICAL SOCIETY (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 4.30 p.m.—Mr. A. J. Philpot: "Physics and the Scientific Instrument Industry".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—The Rt. Hon. Lord Rayleigh, F.R.S.: "Pebbles of Regular Shape, and their Reproduction in Experiment".*

CHEMICAL ENGINEERING GROUP (joint meeting with the GLASGOW SECTION OF THE SOCIETY OF CHEMICAL INDUSTRY and the INSTITUTION OF CHEMICAL ENGINEERS) (at the Royal Technical College, Glasgow), at 7.30 p.m.—Mr. Frank Broadbent: "Centrifuges".

Saturday, March 4

BRITISH ASSOCIATION OF CHEMISTS (LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. T. J. Drakeley: "Training for the Chemical Industries".

GEOLOGISTS' ASSOCIATION (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. H. H. Read, F.R.S.: "Meditations on Granite", Part 2 (Presidential Address).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATES (3, temporary) for MATHEMATICS and SCIENCE at the Hammersmith School of Building and Arts and Crafts, Lime Grove, London, W.12, and a GRADUATE (temporary) for MATHEMATICS and ENGLISH SCIENCE (CHEMISTRY, PHYSICS, MECHANICS) at the Clapham College Annexe, Nightingale Lane, London, S.W.4—The Education Officer (T.1), County Hall, Westminster Bridge, London, S.E.1 (March 1).

ASSISTANT MASTER IN MATHEMATICS AND SCIENCE in the Junior Technical School—The Principal, Royal Technical College, Salford 5, Lancs. (March 1).

DIRECTOR OF THE IMPERIAL AGRICULTURAL RESEARCH INSTITUTE, Government of India—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. O.N.F. 2080A) (March 1).

RESIDENT ENGINEER (location, Northern Ireland), to take charge of Construction Work in connection with an important Power Station extension and High Voltage Transmission Lines, Switching Stations, etc.—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.759.XA) (March 4).

ASSISTANT IN THE HORTICULTURAL DEPARTMENT, with practical experience in Fruit Growing and Commercial Horticulture, to organize spraying operations and supervise the proper cultivation of orcharding—The Chief Executive Officer, Hereford War Agricultural Executive Committee, 4 St. John Street, Hereford (March 5).

ASSISTANT LECTURER IN THE MINING DEPARTMENT of the North Staffordshire Technical College—The Clerk to the Governors, Town Hall, Hanley, Stoke-on-Trent (March 6).

EXECUTIVE ENGINEERS, Grade IV, for the Nigerian Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.773A) (March 6).

IRRIGATION ENGINEER by the Government of Northern Rhodesia—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.784A) (March 8).

PHYSICIST—The Registrar, University College, Hull (March 9).

SENIOR DIETICIAN (woman, temporary) by the Department of Health for Scotland—The Ministry of Labour and National Service, Appointments Office, 5 Rothesay Terrace, Edinburgh 3 (March 11).

PRINCIPAL—The Clerk to the Governors, Harper Adams Agricultural College, Newport, Shropshire (March 18).

PROFESSOR OF MECHANICAL ENGINEERING in the Benares Hindu University Engineering College—The Secretary, Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1 (March 18).

COMMISSIONS IN H.M. FORCES (a limited number) will be granted to candidates who are University-trained Biologists, preferably men with some experience of malaria or entomology—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. ONF.2057A) (March 18).

UNIVERSITY CHAIR OF ANATOMY tenable at St Mary's Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 20).

WAYNFLETE PROFESSORSHIP OF METAPHYSICAL PHILOSOPHY—The Registrar, University Registry, Oxford (April 13).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

TEACHER (part-time) OF ANIMAL PHYSIOLOGY in the Department of Biology—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3.

ASSISTANT LECTURER (temporary) in AGRICULTURAL CHEMISTRY—The Registrar, The University, Reading.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Imperial Agricultural Bureaux. Photoperiodism in the Potato. By C. M. Driver and J. G. Hawkes. Pp. 36. (Cambridge: Imperial Bureau of Plant Breeding.) 2*s*. 6*d*. [201

The Place of Science in China. By Yap Pow-Meng. Pp. 24. (London: China Campaign Committee.) 6*d*. [201

Institution of Mechanical Engineers. Rules for Examinations and for Submission of Theses. Pp. 16. Supplement to Rules for Examinations and for Submission of Theses. Pp. 16. (London: Institution of Mechanical Engineers.) [201

Other Countries

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TRAINING FOR CITIZENSHIP

With so much now being said and written about the future of education, goes the very serious query : Education for whom and for what ? Incorporated in any reply to this should surely be the conception of good citizenship ; and to-day, surveying the state of his country and the world, the enlightened citizen everywhere insists that much more shall be done in this direction. It was with this knowledge of the convictions of many thinking people that the Secretary of State for Scotland early in 1943 instructed the Advisory Council on Education in Scotland "to consider how the educational system of Scotland can most effectively contribute to training in the duties, rights and practice of citizenship, and make recommendations". The considerations and findings form the basis of a report* ; it has been written clearly and precisely, and will commend itself to men of science not only for its valuable subject-matter but also as an example of the way in which such reports should be written.

Before embarking upon its investigation, the Council considered the purpose of citizenship and concluded that its objects are fourfold. It should train young people : (1) to become good husbands and wives and fathers and mothers ; (2) to develop the spirit of responsibility and of tolerant co-operation with their fellows, in work or leisure activities ; (3) to take an intelligent and independent part in the affairs of the community, both local and national ; (4) to have a sense of membership of the world community.

The Council then states quite plainly that, under prevailing conditions, the practical application of citizenship training in many schools is hindered by home and social conditions over which the schools have no control. Until slums are abolished and housing conditions greatly improved, the schools cannot be blamed if the training for citizenship which they give does not produce the desired results. But no school must be allowed to relax its efforts because home conditions make training comparatively useless or ineffective. These conditions must rather be regarded as a challenge, and the vision of better conditions in the post-war world as an incentive to increased effort.

Two main recommendations are made by the Council which, in its view, should serve as the basis for immediate action. First of all, it is strongly recommended that "the next five years be set apart as a period of experiment and of deliberate striving towards a theory and practice in training for citizenship". Secondly, it is suggested that soon after the end of the second year of the quinquennium of experiment, the Scottish Education Department should publish a report indicating the plans and experiences of the schools, whether successful or not. During the remaining period of the experiment, further reports should be published annually, and should outline the more active and successful features of the school programmes, as well as experiments

* Training for Citizenship. A Report of the Advisory Council on Education in Scotland. H.M. Stationery Office. 6*d*. net.

which have not produced the hoped-for results, thus enabling schools to make such changes in their own schemes as the experience of other schools may indicate. At the end of the term of experiment, it might be possible to decide whether local autonomy and experiment might continue to serve as a national plan of training for citizenship, or whether the plan of training should be basically similar throughout Scotland.

These recommendations cannot fail to meet with approval, not least from men and women who use the experimental method as their basis for decision and judgment. Instead of the haphazard and slipshod methods which have been the companions of educational reform, it is suggested that this controlled period of five years be used as a time of inquiry, observation and collation.

It is rightly recognized that the new importance which must be attached to training for citizenship "will involve some change of emphasis in the work of the schools. While they will continue to impart knowledge and to prepare children for life and work, they will, more than ever before, become the training ground where the future citizens will learn what they are expected to become as members of a free and democratic community; and from this point of view, what they are and what they become is more important than what they know. In our view it is not possible to adapt the present machinery of education effectively to these changed conditions without prior experiment."

The Council then discusses some of the methods by which the five-year experiment should be governed. Almost all the witnesses who were consulted consider it essential that a school should be regarded as a small community within the larger community. This is set out as the first proposal. Children should know and share in the duties and responsibilities of citizenship, and, as the child grows older, the more definite should training for citizenship become. In many schools a great tradition and a distinctive atmosphere have been built up, mainly by the personality and united efforts of successive headmasters and their staffs. The character of the future citizen and his philosophy of life will at many points be built upon the tone of his school and upon the influence and character of his teachers. This responsibility must be accepted in a very real way by the heads of the schools and must be willingly discharged by them and their colleagues. It is important, therefore, that authorities charged with making appointments to schools should secure men and women of the right personality and temperament. In order to ensure harmonious working of a school staff, governing bodies should take the heads of schools into closest consultation and endeavour to make new appointments of staff acceptable to them. Training colleges will need to exercise a more discriminating selection of intending students and should take steps to reject unsuitable students at any period of their training. Much misery would be prevented by these rejections.

The problem of backward children calls for more study, with the view of developing means of dealing with them other than by segregation. When segregation is found to be the only practicable method, this should be applied at an earlier stage than is at present customary. In the primary school, classes should be reduced to a maximum of thirty; but even under present conditions experiments should be made in handling the individual class as a small community within the larger community of the school.

In the junior and secondary schools, the present system of using specialist teachers for different subjects often means that these teachers do not see their pupils often enough to gain an intimate knowledge of them as individuals. It is suggested that the experiment be tried of appointing class masters or mistresses who would give the pupils sympathetic guidance both in and out of school. The more these teachers learn of the home conditions of their scholars the more effective would their influence be.

The appointment of prefects or monitors in senior secondary schools and the organization of a house or nation system have afforded opportunities for an excellent training in the responsibility of leadership. Experiments should now be made to cover such questions as the best methods of electing or appointing the prefects or monitors or other group-leaders. Classes might be divided for certain class-room or recreational activities into balanced groups, each with a leader and sub-leader. In all secondary schools and large primary schools which are co-educational there should be a woman superintendent; in all large schools the headmaster should be given adequate clerical assistance.

Although the boarding school is a comparative rarity in Scotland, its value as a training ground for citizenship is fully recognized by the Council. It is suggested that experiments should be made in sending secondary school pupils to such schools.

In order that school leavers may be more suitably placed in jobs, the Council recommends that the Scottish Education Department should consult with the Ministry of Labour as to what revision of the present system is needed to make it most effective. The appointment of careers masters and mistresses might be one of the means by which experiments could be conducted.

New school buildings should be functionally suitable for their purpose. They should be well equipped for the business of teaching and for those needs that may develop out of youth service and community movements of the future; where old buildings are to be retained they should be periodically revitalized.

The Council's second proposal for the five-year experiment is that there should be close and continuous collaboration between parent and teacher. A concerted plan must be evolved in which the schools, the homes, and all the other agencies concerned with children play their part. Although the parent-teacher association has not met with great success in Scotland, it is suggested that the movement be fostered and that other movements for collaboration be inaugurated.

The third proposal is concerned with moral and religious training. Experiments should be made in giving definite lessons in the principles of right and wrong conduct. The teaching of 'human relations', in the course of which every child considers the results of his own and other people's actions, good or bad, should be tried. This is already in vogue in the State of California and has given valuable results. An experimental schools code of good conduct, similar to scout law, could be produced and the effects of the code in schools carefully observed.

In the respective spheres of responsibility of the Secretary of State and of the Education Authorities for religious instruction, the Council considers that no change is desirable. The true Christian spirit should pervade the whole school and nothing should be done which might create the impression of hypocrisy. The practice of holding a morning service should be encouraged and on special occasions services in nearby churches should be encouraged. Definite periods should be set aside for religious instruction and should include periods other than those at the beginning or end of a meeting of the school. Close co-operation between the churches and the education authorities in each area should be constantly practised.

Special study and experiment is needed on the training of teachers for religious subjects. But the Council is unanimous in recommending that only believing Christians should be entrusted with the duty of giving instruction on religious subjects in schools. The qualifications of the teachers concerned will vary with the type and age of pupil; the Council proposes to issue a further report relating to this point.

Proposals for moral and religious training lead naturally to the fourth proposal, which deals with æsthetic training. Here it is emphasized that the appeal of beauty plays an important part in the building up of the good citizen. No education is considered complete unless an attempt is made to develop in the child some æsthetic appreciation of art, music and the beauties of Nature. Further experiments should therefore be made into the methods of teaching children how to appreciate line, form, colour, tone and rhythm, while every child should be given the opportunity of drawing and painting and practising the crafts for which he or she shows aptitude. Direct participation in musical activities should be encouraged, and the appreciation of good music should be taught at every opportunity. The facilities offered by the Council for the Encouragement of Music and the Arts and the British Institute of Adult Education in their presentation of good music, drama and art exhibits should be freely used. One must commend the Council for a proposal which, if generously interpreted and acted upon, might ultimately offer to many people the solution of their leisure problems.

Men of science will readily accept the next proposal, which deals with the promotion of good health. For the integration of the personality, bodily health is of prime importance. From their earliest years children should be taught the elementary facts of personal hygiene; physical training should form part of the daily routine of all schools and, so far as possible, should be carried out in the open air. Parents, too, should be reminded of the need for adequate sleep for their children.

Another proposal deals with the prevention of accidents. It cannot be too strongly stressed that the rules of safety are not inherent and must be taught. There is scope for further experiment and for co-operation between school, home and other agencies.

The Council regards it of first importance that all children should be instructed in the simple facts of sex, and suggests the appointment of a committee to investigate methods by which sex education might be introduced into schools. This committee, no doubt, will use much of the material and derive inspiration from the recent publication of the Board of Education on this important subject (NATURE, **152**, 582; 1943).

The eighth proposal towards the training of the good citizen is concerned with the contribution of the individual school subject. It is suggested that English, geography, history and civics each has a special contribution to make towards training for citizenship. No one would wish to deny the peculiar importance of the subjects mentioned; but the omission of any reference to the value of science as a social discipline must be strongly deprecated. The Council should seek further evidence and rectify this unfortunate omission immediately.

A knowledge of local history and tradition as preparation for citizenship is of special significance. Schools should be invited to concern themselves with local interests and the revival of historic ceremonies and festivals. This would encourage the growth of the community spirit and would do much to awaken in young people the desire to take part in the development of their own neighbourhood. Later the need for positive teaching would arise, and the child should be made aware, through facts within his personal observation, of the responsibility which local authority and the central government services are discharging for the health, convenience and security of the community. Many experiments could be undertaken to investigate the most suitable methods of teaching these positive aspects of civics.

The last proposal in training for citizenship relates to the contribution of the several parts of the educational system. Each type of educational organization, from nursery school to university, has its own peculiar part to play in the making of good citizens. The Council recommends, therefore, that comprehensive investigations be set in process to consider the special place of each type of educational organization in serving the needs of the future citizen; special attention should be given to mentally backward children.

The report concludes with a valuable statement about the real origins of juvenile delinquency and their amelioration. It is scarcely necessary to say

that there is no sovereign remedy which is likely to have an immediate and substantial effect on the problem of the young offender; but the Council rightly emphasizes that many of the suggestions which it has made cannot fail to take effect in the long term. The major cause of juvenile delinquency often lies in the home. With the coming of the educational facilities outlined in the Education Bill and the provision of better homes and healthier conditions of living, the evil of juvenile delinquency should be considerably reduced. Where delinquency is obviously not due to home conditions, the schools must do everything possible to alleviate the handicaps or maladjustments at the root of individual cases of delinquency. The problem of truancy should be attacked in its early stages; school attendance officers might profitably be replaced by school welfare officers. Children whose delinquency is due to inherent mental defect should be referred to child guidance clinics, the total number of which should be considerably increased.

Lack of opportunity for healthy exercise is a frequent cause of juvenile delinquency, and an extension of holiday facilities in the country for city children should be urgently considered, as should the provision of an increased number of playing fields.

Much of the material in this report is applicable to the educational organization in any country, and the people of England and Wales would do well to appropriate for themselves most of its spirit and many of its recommendations. A great deal is expected from the Advisory Councils for England and Wales, the constitution of which is adumbrated in the Education Bill. These Councils should copy their Scottish counterpart and direct their early attention to ways in which good citizenship can be developed. In their deliberations they should take pains to point out that, however paradoxical, good citizenship is not confined within national boundaries.

Recently there has appeared a number of White Papers on various aspects of education. Most of them have been concerned with pressing problems of current importance and have presented the problems with dignity and earnestness. Now, if one reads the signs of the times aright, the time has come when we have to decide one way or the other about issues like the one outlined in this report; and having made our decision, we must then translate it into action. Future developments must be planned so that the most needed requirements are given priority for action. Here we must be on our guard that the more intangible requirements like good citizenship shall not be shelved in favour of the more material and obvious aspects of reconstruction. If we decide now to institute adequate schemes of citizenship training along the lines indicated in this report and, equally important, inculcate a positive attitude towards world citizenship as set out in Brimble and May's recent book*, many of the other things will follow. The good citizen will see to that.

* Social Studies and World Citizenship; a Sociological Approach to Education. (Macmillan and Co., 1943.)

AN ARISTOTELIAN ON LOGIC AND GEOMETRY

(1) Études sur la connaissance mathématique
Par Prof. Thomas Greenwood. Pp. viii+112. (Ottawa: University of Ottawa, 1942.) 1 dollar.

(2) Essais sur la pensée géométrique
Par Prof. Thomas Greenwood. Pp. 100. (Ottawa: University of Ottawa, 1943.) 1 dollar.

(3) Prolégomènes à la théorie des quanta
Par Prof. Thomas Greenwood. Pp. 61. (Ottawa: University of Ottawa, 1943.) 60 cents.

THERE is now a great deal of coming and going between natural science and metaphysics. On the mathematical-physical side there is a succession of writers from Whitehead and Russell to Jeans, Eddington and Dingle, while professional philosophers such as the late Prof. Susan Stebbing have studied the new atomic and cosmic physics in order to find whether they have any metaphysical repercussions. The volumes under review, which are published by the French-Canadian University of Ottawa, witness to the interest that is now taken in these problems all over the world.

A worker of real eminence in one of the two fields is apt, when he crosses over into the other, to make mistakes. In view of the difficulty and importance of what he is trying to do, there will be general agreement that the proper attitude to take on these occasions is a charitable indulgence; and of this, it must be said, Prof. Greenwood is often in need so far as concerns one of these three books, namely, that on quantum theory; as the following quotations will show:

"Un corps noir à une température donnée émet une série de lignes coloriées qu'on nomme son spectre" (p. 10).

"La différence de fréquence de deux raies quelconques d'un spectre est la fréquence d'une autre raie du même spectre" (p. 10).

"Un corps noir . . . à 500° C. commence à donner des rayons monochromatiques; à 1200° C. le rayonnement est blanc; à 3,400° C. il atteint son intensité maximum" (p. 11).

"D'après le principe de la moindre action de Maupertius, l'action d'un électron vibrant avec une énergie E serait $\int mvds = E/\nu$" (p. 13).

"Les rayons-γ ne sont que des courants rapides d'électrons" (p. 15).

"Pour toute équation differentielle, on peut trouver des solutions finies, universelles et continués seulement si le paramètre contenu dans l'équation a des valeurs définies" (p. 25).

"Une matrice est *symétrique*, lorsque tous ses éléments situés symétriquement par rapport à la diagonale principale ont leurs suffixes égaux, mais intervertis" (p. 33).

It is to be regretted that the author did not submit his manuscript to some competent physicist before sending it to the printer.

This unfortunate venture should not be allowed to prejudice the reception of the other two works, which contain much valuable and stimulating reading. The first of the "Études" is devoted to mathematical logic, where Prof. Greenwood is on his own territory and has many interesting things to say. He belongs to the conservative wing, and deplores the tendency of some writers to regard the Aristotelian-scholastic

logic as obsolete. To many it might seem as if the superiority of the new symbolism was now beyond all question: for it has triumphantly solved problems with which the traditional logic trifled impotently for two thousand years. There is, however, another side to the question; it is necessary to distinguish between two different aims which the logician may propose to himself: he may wish to increase his power and facility in drawing inferences, or he may wish simply to investigate the theory of logic in itself. For the former purpose the advantages of the symbolism are indisputable; but in regard to the latter, the Aristotelians do not admit inferiority. Perhaps their most vulnerable spot is the doctrine of relations; more than eighty years ago they were teased about it by De Morgan, who issued challenges such as "To prove by traditional logic that *if cows are animals, the tails of cows are tails of animals*", and "To deduce the classes of men specified in *the non-ancestors of all non-descendants of Z*". Prof. Greenwood proposes to gather relations into the Aristotelian fold by considering the relation and the related predicate as *the* predicate, and the judgment as a declaration or denial of identity between this and the related subject, so that all relations are reduced formally to those expressed by *is* and *is not*; working out this idea, he claims that the calculus of relations can be added "comme un nouveau chapitre à la logique classique, sans devoir le présenter comme une innovation exigeant une transformation complète des bases de cette logique".

The "Études" include interesting and learned discussions of the mathematical ideas of Aristotle and St. Thomas, and the "Essais" contain an entirely original treatment of the foundations of Euclidean geometry.

In conclusion, one may refer to an opinion of Prof. Greenwood's (in support of which he quotes St. Thomas), that "Le caractère purement formal des sciences mathématiques rend celles-ci bien plus faciles à étudier que les autres sciences: et par conséquent elles sont particulièrement avantageuses pour l'éducation des jeunes". It is interesting to speculate how St. Thomas would have handled the modern agitation to allow girls to learn botany instead of mathematics, because mathematics is too hard for them.

E. T. WHITTAKER.

RESEARCH IN SOCIAL ORGANIZATION

The Peckham Experiment

A Study in the Living Structure of Society. By Dr. Innes H. Pearse and Lucy H. Crocker. (Published for the Sir Halley Stewart Trust.) Pp. 334+16 plates. (London: George Allen and Unwin, Ltd., 1943.) 12*s*. 6*d*. net.

THERE was a time I wished I lived in Peckham, for in 1926 the Pioneer Health Centre was opened there by a group of young people who set out to study health and to foster conditions in which it could be maintained. They offered to families the facilities of a well-provided social club, and a periodic health overhaul. It would have been nice to be one of their 'guinea pigs'; the social experiment alone was commendable, and the possibilities of a new kind of medical research seemed enormous. The first two books published by the Peckham 'biologists', "The Case for Action" (1931) and "Biologists in Search of Material" (1938), were disappointing, but it was perhaps too early to decide whether they were a little 'cranky', or merely picturesque. To social biologists, however, "The Peckham Experiment" is even more disappointing. It gives a lengthy exposition of the experimenters' philosophy and descriptions of life at the Centre, but it reports very little advance on the results of research published in its predecessors. These results were certainly interesting and sometimes unexpected. For example, only about 10 per cent of the Centre members had no physiological defects, and about 68 per cent had some disorder but were seemingly well. The high incidence of worm infestation, reaching so much as 41 per cent in boys of 6–10 years of age, is surprising. Two further interesting findings published earlier but not unfortunately expanded in this book are the frequent occurrence of a state of mild chronic debility and the profound physiological effects of night work.

As is to be expected, the results of periodic medical examinations give the Peckham workers plenty of support for their belief that "nothing short of periodic health overhaul on a national scale can lead to the rational application of medical science for the elimination of Sickness". Health centres have the opportunity of studying groups of the population at present far too little known to medical science: the normal group, the group oblivious of organic disease in its early stages, and the group unpleasantly aware of clinically uninteresting chronic debility. The Peckham biologists have demonstrated something of the importance of these groups, but we still await indications of an intensive research programme designed to take advantage of their material. The newness and difficulty of research on the health and sickness of a whole population possibly makes impatience unfair. But most readers of this book will wonder whether they will ever feel satisfied that the research is on the right lines. It is difficult not to feel that their preconceived ideas about "the Living Structure of Society" stand in the way of the experimenters.

The authors say "We claim to have defined the unit of Living. It is not the individual, it is *the family*. This has opened up a new field for experiment into social organization. . . ." But they deliberately rejected necessary controls for their experiments on the "unit of Living", for they refused to consider the 'non-family' by making it a condition of membership of the Centre that the family should join as a whole. Thus their observations were limited to a selected population from which isolated individuals and broken families were excluded. Moreover, the experimenters threw away a unique opportunity for studying the effects of family disintegration (as well as those of other incidentals of war such as the black-out, air-raids, changes of diet), for "The Centre's activities were suspended at the outbreak of war, September 1939, owing to the inevitable dispersion of the family unit in war conditions".

Further, the Peckham biologists' concept of the family as a functional unity or organism leads them to deduce a new physiology. Some quotations will illustrate its unusual flavour: ". . . by the time fertilisation has taken place the blood of the mother has been sensitized and attuned to that of her mate, father of the embryo. Thus, from the moment the new individual begins to develop, there is already a *physical* basis for a 'functional organisation' between the three individuals of the growing family" (p. 34). When a couple announces that conception has

occurred the physical changes which take place in the pregnant woman are described to them: "Her tissues become fluid and softened so that, for instance, in some you can almost bend the bones under the finger. All the tissues undergo this change—liver, bones, hair, eyes, brain—all are flooded with the circulatory fluids of the body so that their essence seeps out and is carried round in the blood to the womb where the growing child can draw upon it for its nourishment and growth" (p. 87). It is perhaps not surprising that one of the very few research projects the authors mention is not of great practical importance: "Experiments were under way at the Centre, before war brought our work to a close, to find bio-chemical evidence in the father of parenthood occurring in the family".

In evaluating the work of the Peckham Pioneer Health Centre, a biologist is driven to judge the social and scientific aspects of the work very differently. There can be no doubt that the members of the Centre benefited socially and medically from its services; but the scientific results published in these books do not seem commensurate with the opportunities offered. I think it is important to indicate that the defect lies not in the nature of health centres, but in the preconceived ideas of these experimenters. While great credit must be given to the Peckham biologists as pioneers in the health centre movement, it would be a pity if further progress in such an important technique of medical research were prejudiced by their views and methods, which many people will find scientifically unacceptable.

M. L. JOHNSON.

CHEMISTRY OF LARGE MOLECULES

The Chemistry of Large Molecules

Edited by R. E. Burk and Oliver Grummitt. (Frontiers in Chemistry, Vol. 1, published under the auspices of Western Reserve University.) Pp. xii+313. (New York: Interscience Publishers, Inc.; London: Imperia Book Co., Ltd., 1943.) 3.50 dollars.

"THE Chemistry of Large Molecules" is the first volume of a new series entitled "Frontiers in Chemistry" and is composed of eight sections written by experts in the field of macromolecules. The first two sections, compiled by Dr. H. Mark, give a rather brief account of the kinetics of poly-reactions and of the mechanism of condensation, and a concise record of the information available from X-ray study of large molecules. Dr. Kraemer then discusses in the next section the colloidal behaviour of solutions of macromolecules with special reference to the relatonship between viscosity and molecular weight. The same author also contributes a good summary of the application of the ultracentrifuge to the study of large molecules.

Section 5, compiled by a team of three experts, is an advanced mathematical treatment of the elastic-viscous properties of long-chain molecules, while the electrical properties are discussed by Dr. Friess in Section 6. The work of Marvel and his collaborators on vinyl polymers is well known, and is here summarized in Section 7 by Dr. Mark himself. The last section in the book deals with the chemistry of cellulose and cellulose derivatives, and is written by Dr. Ott. Each section is supported by an adequate bibliography.

In a foreword the editors of this book explain that Western Reserve University conceived the idea of inviting scientific workers distinguished in particular fields of chemistry to give two lectures each on his particular subject, and the book is based on such lectures. As the title of this series of books suggests, the subject-matter is to be found on the "Frontiers of Chemistry". It is therefore definitely a book for the expert, and of particular value to those who are investigating the course of polymerization and the theory of the reactions.

Much publicity is given at present to macromolecular structures; but the reader will find in this book practically nothing of the spectacular industrial applications of these materials. Instead he will find fundamental mathematical and physico-chemical reasoning, and it would be true to say that without a good knowledge of these sciences the reader will find the book heavy reading.

D. D. PRATT.

SKOKHOLM

Dream Island Days

A Record of the Simple Life. By R. M. Lockley. Pp. 144+8 plates. (London: H. F. and G. Witherby, Ltd., 1943.) 10*s.* 6*d.* net.

FOR "some to discover islands" is a recognized career for men, like "some to the wars", or "some to the studious universities". Such islands are mostly far away; but to rediscover the forgotten and reoccupy the abandoned ones is work for R. M. Lockley, Compton Mackenzie, Fraser Darling, Seton Gordon, and other men of like calibre. For a man's island is his kingdom, and becomes his paradise; and a bird-lover among his own island-birds lives, as it were, in Eden.

This book is not a new one. It mostly repeats what Mr. Lockley wrote about his "Dream Island" some fifteen years ago; but he lived there for years after, until there was no more peace anywhere, and now he tells the 'simple story' of his island-life, with wife and child, among the wildfowl. The usual lover of birds has his life embittered by the sportsman and his game-keeper or 'vermin-killer', who spend their selfish lives slaughtering falcon and buzzard, crow and raven, merlin, jay and magpie, and many another beautiful creature which has its place in poetry and its corner in the kindly hearts of men. But on one's own island one lives at peace with all bird-kind, even—by a stretch of charity—with the great black-backed gull.

Mr. Lockley's book on "Shearwaters" was one of the great bird-books of our time. Now we may read again of that strange sea-fowl, which meets us in Homer and in Virgil and in Ovid; which is here by thousands; which flies from Pembroke to the Bay of Biscay for its dinner; which sits for two full months on its solitary, subterranean egg; which feeds its downy chicken for two months more, and then leaves it lonely and desolate (but a delicious morsel) until hunger drives it to seek the unknown sea. We walk round the little island; pass by 'Puffin-town' with its population of 40,000 puffin-souls; tread on wild-thyme, campion and sea-pink; watch the pair of ravens and the pair of peregrines, part-owners of the place; and see the few choughs and many carrion crows, the whin-chats and the meadow-pipits, perhaps the host of migrants in the spring; and the grey seals on the beach below the cliff. A wonderful place, and a delightful book—too good for anybody but a naturalist.

D'ARCY W. THOMPSON.

Mathematical Recreations

By Prof. Maurice Kraitchik. Pp. 328. (London: George Allen and Unwin, Ltd., 1943.) 12s. 6d. net.

THERE is reason to suppose that in at least some cases an interest in mathematics develops out of an interest in puzzles and problems, rather than from an interest in straightforward arithmetic. For those whose interests in mathematics have already been aroused, there are collections of mathematical recreations, of which the best known to the British reader are W. W. R. Ball's "Mathematical Recreations and Essays" and H. E. Dudeney's "Amusements in Mathematics". Ball's book, especially as revised by H. S. M. Coxeter, lays the emphasis on the mathematics. However apparently frivolous the starting point, the reader soon finds himself guided, gently but firmly, into an approach towards important mathematical principles. Dudeney's book, on the other hand, lays the emphasis on the amusements, and appeals more to the type of person who delights in listening to the "Brains Trust".

Prof. Kraitchik's book, based on a course of lectures delivered in New York, may be regarded as a revised edition of his "La Mathématique des Jeux" (Brussels, 1930), enriched by his nine years editorship of the periodical *Sphinx*. His treatment is something like Ball's, but not quite so serious, and with much more attention to problems connected with games, including not only chess, "checkers" (draughts), "craps" (dice) and dominoes, but also several games very little known in England. The discussion of the chess rook's moves leads to an introduction to the theory of groups. There are twelve chapters: mathematics without numbers, ancient and curious problems, numerical pastimes, arithmetico-geometrical questions, the calendar, probabilities, magic squares, geometric recreations, permutational problems, the problem of the (chess) queens, the problem of the (chess) knight, and games. The longest two chapters are on numerical pastimes, which contains a good deal about the theory of numbers, and magic squares. The chapter on geometric recreations contains several interesting diagrams of mosaics. H. T. H. P.

A German Physics Reader

By J. E. Calthrop. Pp. 83. (London and Toronto: William Heinemann, Ltd., 1943.) 7s. 6d. net.

THE steady growth of physics places a great strain upon students and teachers of the subject and a continual look-out is kept for means of lightening the work by omissions. Unfortunately, the study of German cannot be omitted. If no more physics were published in German, it would still be necessary for many years that the physicist should at least 'muddle through' a passage in German well enough to use the German handbooks and to read research papers in his subject. There are three minimum requirements. An elementary knowledge of the grammatical and constructional difficulties of scientific German, a basic vocabulary and a thorough knowledge of physics to make up for deficiencies in the first two.

The present volume can supply the second requirement—an excellent basic vocabulary. As the title implies, the book consists chiefly of passages in German on physics, and no help at all is given with grammar. Section 1 contains eleven extracts on the history of physics, ranging in subject from Brownian movement to radioactivity. A translation of each passage is given on the opposite page. Section 2 gives thirty passages, each with its own vocabulary. Section 3 reproduces more than thirty science German questions from University of London examination papers. There is no collected vocabulary or index at the end of the book and the beginner would need also such a volume as Wiener's "German for the Scientist" (Bell, 1943). The price seems rather high by comparison with Wiener's book, but there is no doubt that the selection of passages is the most comprehensive so far published for the physicist. Each extract is of interest for its content and is full of words commonly occurring in the literature. The book can be strongly recommended. W. H. G.

An Introduction to Pure Solid Geometry

By Dr. G. S. Mahajani. Second edition. Pp. xiv+104. (Poona: Aryabhushan Press, 1943.) 3 rupees.

THIS is the second edition of a book originally published in 1940. It is designed for intermediate and inter-science students at Indian universities. Its five chapters deal with lines and planes in space, the tetrahedron and parallelopiped, mensuration of prisms and cylinders, the sphere, solid angles and polyhedra. An appendix is provided in which the volume of a prismatoid is discussed. An excellent set of miscellaneous exercises then follows.

In order to clarify the subject and thus avoid any confusion in the mind of the student, the author has attempted to cover the essential subject-matter in the smallest number of theorems—and the attempt has been very commendably carried out. Many exercises are given which can be regarded as bookwork, and to several of these, solutions are indicated. As with the author's "Elementary Analysis", the exposition is particularly lucid and should give the student a thoroughly clear perception of the fundamental principles of solid geometry. In this new edition, the text has been rewritten and rearranged. Several new paragraphs have also been added in order to render the relevant treatment self-contained. The number of exercises, too, has been increased. The book is a model of mathematical precision and clarity, and should be very useful as well as stimulating to all students of the subject.

Air-Borne Infection

Some Observations on its Decline. By Prof. Dwight O'Hara. Pp. x+114. (New York: Commonwealth Fund; London: Oxford University Press, 1943.) 8s. 6d. net.

CHANGE in virulence of certain diseases with the passage of years is a well-recognized phenomenon. Nowhere is this change so marked or, relatively, so rapid as in the diseases of the respiratory system. The last twenty-five years have seen a tremendous reduction in the mortality-rate from respiratory infections, and Prof. O'Hara has surveyed the possible explanations for this decline. He ascribes the decline to increased biological resistance rather than to any public health or therapeutic measures. Many will agree with the author in his contention that active immunity is better than passive, and that an otherwise healthy child should acquire its full immunity through having a disease such as measles rather than by being partially protected by convalescent serum. The observations on the common cold as an entity and as an abortive form of other respiratory diseases are of particular interest. The book as a whole is worthy of attention from specialist and general practitioner alike.

Lessons in Elementary Analysis

By Dr. G. S. Mahajani. Third edition. Pp. xiii+298. (Poona: Aryabhushan Press, 1942.) 6.4 rupees.

THIS useful book, first published in 1929, was reviewed in NATURE of November 7, 1936. Being designed to cover the analysis required for the bachelor's degree at most of the Indian universities, it has evidently well served its purpose, for a second edition was issued in 1934, and this third edition in 1942. There are twelve chapters devoted to the arithmetic continuum, the theory of limits, infinitesimals, continuity, mean value theorems, Taylor's theorem, integrals, including a treatment of mean value theorems and infinite integrals, uniform convergence, inversion of operations and Fourier series. While the general plan of the course remains unchanged, advantage has been taken in this edition to make several important additions. Thus, Landau's method of proving the second mean value theorem now appears, while a note on Frullani's integral is given in the addendum. Chapters 9 and 10, on infinite integrals and uniform convergence, have been rewritten, and the number of illustrative exercises at the end of each chapter has been increased.

The exposition is exceptionally clear and quite rigorous. While the lessons have been skilfully woven into a thoroughly coherent course, each chapter is almost a separate entity and can be studied as such. The sets of exercises also should serve to stimulate the student to further study.

Pasteurisation

By Harry Hill. Pp. viii+152. (London: H. K. Lewis and Co., Ltd., 1943.) 10s. net.

DESPITE its comprehensive title, this is not a treatise on pasteurization generally, but deals only with a relatively few, though important, aspects of the pasteurization of cow's milk. Nevertheless, the author goes outside his title to include sections on sterilization of milk, on homogenization and on ultra-violet irradiation of milk.

The value of this book lies, not in the first 34 pages, in which a case is made for compulsory pasteurization, but in two subsequent chapters, one on design of plant used for heat treatment of milk and the other on methods of control of the efficiency of such plant. Everyone dealing with the designing, erecting, licensing and management of plants for the commercial heat treatment of milk could read these pages with advantage. The book's appearance is particularly opportune for those who, if the recent White Paper "Measures to Improve the Quality of the Nation's Milk Supply" (Cmd. 6454) becomes law, will have additional duties to perform either of an advisory or control character in respect of heat treatment of milk.

Printing, paper and binding are all good; but it is to be hoped that the complete absence of diagrams will be remedied in the next edition.

Clubs and Club Making

By various Authors. Issued by the National Association of Girls' Clubs. Edited by Dr. J. Macalister Brew. Pp. 104. (Bickley: University of London Press, Ltd., 1943.) 2s. net.

THE launching of the Service of Youth movement soon after the outbreak of war has been followed by a growing interest in the means whereby adolescence could be most ably guided towards balanced maturity. There is an increasing number of people who are seeking to serve in this important and valuable work and the number will continue to grow with the birth of the new Education Bill. To help these potential youth workers the National Association of Girls' Clubs has produced this little book. It has been compiled from a series of pamphlets which have been previously issued by this and the corresponding boys' organization, the National Association of Boys' Clubs. The description of various club activities, as well as club administration, is presented with sympathetic understanding of beginners' problems, while the meticulous attention to detail on practical issues leaves little to be added. One readily agrees with the authors' conclusion that the book makes no claim to literary excellence, but that should in no way detract from its usefulness as a handbook for prospective and practising club leaders.

Aerodynamics of the Aeroplane

By W. L. Cowley. (Nelson's Aeroscience Manuals.) Pp. 201. (Edinburgh and London: Thomas Nelson and Sons, Ltd., 1943.) 5s. net.

ADMITTEDLY it is difficult to write an elementary book on a mathematical subject like aeronautics, to give the main principles and yet steer clear of the more difficult mathematics involved. The attempt to do this has been made in this book, and to give an elementary survey of present-day aerodynamic conceptions to students of matriculation standard.

The young student will find a great deal to 'bite' at, but on the whole he is likely to find it rather 'heavy going' to digest it. The presentation of the material might have been done in a more interesting and more inspiring manner. The beginner is made to realize that the subject is difficult (as it undoubtedly is), but it probably could be made to *appear* more simple by including many more diagrams; simple diagrams mean much to a young student and are a great asset in a book of this type.

Some parts of the book are very readable and will be enjoyed by the serious student; the pages devoted to the various systems of units are a useful feature. On the other hand, certain other topics, for example, the distinction between mass and weight, could probably have been disposed of in less space.

For a small book the index is very comprehensive, and there are two chapters at the end intended mainly for more advanced students.

Borderlands of Psychiatry

By Prof. Stanley Cobb. (Harvard University Monographs in Medicine and Public Health, No. 4.) Pp. xiv+166. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1943.) 2.50 dollars.

THIS volume contains a series of essays on a variety of subjects, which, as the author says, are neither orthodox medicine, nor psychiatry, nor neurology. The psychiatric aspect of a number of nervous disorders is considered. These include disorders of speech, of emotion and of consciousness.

Apart from the primary concern with the importance of psychiatric treatment in these conditions, which is extremely interesting, the book is noteworthy for clear explanation of the anatomical relations, so far as they are known, of the diseases described.

FUNCTION AND FUTURE OF COLONIAL GEOLOGICAL SURVEYS

DURING the past few years, attention has been directed, from time to time, in NATURE and elsewhere*, to the importance of the work of geologists, to the widespread ignorance, in Great Britain, of geological science, and to the consequent lack of appreciation of the many services which geologists can and ought to perform for the common good. The immediate seriousness of the position lies not so much in the fact that this ignorance should prevail among the community at large, as in the realization that it extends into the administrative and governing classes, both civil and military. There is, it seems, a consensus of opinion that this is the existing state of affairs.

While it may be true that it is often recognized, if not very clearly, that there is a connexion between geology and the production of minerals, it is less commonly realized that geologists are able to render equally important, if less obvious, services in furtherance of other activities closely bound up with human welfare, such as agriculture, civil engineering and, not least, questions of water supply.

The discovery of valuable mineral deposits as a direct result of geological exploration provides from time to time a striking illustration of the importance of such a survey; but it is far from easy to demonstrate to the layman the potential value of the day-to-day work carried out by geologists, including the contributions to pure geology made by government servants. It is nevertheless true to say that the connexion between pure and applied geology is a very close one. The rare mineral of yesterday, the occurrence of which has been recorded for scientific reasons, in many cases has acquired later on an unforeseen commercial value. Similarly, the finding of some obscure fossil in the field, and its identification in the laboratory by a skilled palæontologist, may have important and perhaps immediate consequences in industry. The location of good water supplies, a service in many cases requiring the advice of a skilled geologist, is also work the value of which is not easily assessed. Of not less importance, too, is the fact that the geologist who knows his terrain thoroughly is not infrequently able to give advice that results in saving the community large sums of money that otherwise would have been wasted.

All these considerations suggest that a wise and foreseeing government would be well advised to establish and maintain properly staffed and equipped Geological Surveys, particularly in new and relatively little-known territories such as the British Colonies; and to ensure that the scientific side of the work is not unduly subordinated to the more immediate and obvious economic requirements.

Nevertheless, it still seems to be the case that, even in administrative quarters where there is some appreciation of the nature and functions of a Geological Survey, there is still incomplete realization of the purely economic value of the services such a Survey can render, and hence a lack of willingness to ensure that Geological Surveys under their control are adequately financed.

The repercussions of this state of affairs on the development of the British Colonial Empire were debated recently at a joint meeting of the Geological Society of London and the Institution of Mining and Metallurgy*, which had been specially convened to discuss the "Contribution of Geological Surveys to Colonial Development, and the Future of Colonial Geological Surveys". The debate centred round an address on this subject given by Sir Edmund Teale, formerly director of the Geological Survey of Tanganyika Territory. Prof. W. G. Fearnsides, president of the Geological Society, occupied the chair during the earlier part of the meeting, and his place was taken later by Sir Lewis Fermor, vice-president of the Institution of Mining and Metallurgy, and formerly director of the Geological Survey of India.

In his opening remarks, Prof. Fearnsides stated that the meeting had been arranged as a result of representations made to the Society by some of its fellows, resident abroad, who, being servants of the State, were dissatisfied with the conditions existing in certain Geological Surveys. In view of the economic functions of Geological Surveys, the Council had thought it desirable to seek the co-operation of the Institution of Mining and Metallurgy, as representing the metal-mining interests in Great Britain, and thereby to secure a much stronger and more professional representation at the meeting.

Sir Edmund Teale first of all pointed out that, in view of the attention now given to post-war planning, the time seemed opportune to discuss the extent to which Geological Surveys can play a part in the economic development of British Colonies. He then spoke at some length on the "complete misconception which seems to exist in high places concerning the purpose, scope, requirements and results of the work of Geological Surveys", in the following terms:

"Profound misconception exists, even among some of the highest of our Colonial officers, about the valuable work that has already been accomplished by these geological departments, and this misconception has resulted, even in the best periods, in the total inadequacy of the financial provision made for essential field work, in the reduction, in more critical times, of the existing staff, and in the failure to fill positions left vacant by the retirement of the heads of the Geological Surveys. The view is held by the officers in charge of the finances of the Colonies that Geological Surveys are not revenue-producing departments. This will appear strange to mining engineers and others familiar with the economic aspects of geological work; but there is abundant evidence of the almost complete unawareness among the chief officers of the Crown of the substantial revenue, besides other benefits, which is the direct result of discoveries of mineral deposits made by these Surveys.

"It is clear, as was shown in a short paragraph in an article in *The Times* of September 15, 1943, on tropical African Colonies, that in the view of high authorities the work of Colonial Geological Surveys finishes with mapping, and that that work is now nearly complete! Further, in certain Colonies, Geological, Mining, Survey and Lands Departments have all been merged under one Director, and he without any special training or experience in any of these subjects; many very unsatisfactory situations have thereby been created. In another Colony,

* See Boswell, P. G. H., "The Status of Geology: a Review of Present Conditions", *Proc. Geol. Soc., Q.J.G.S.*, **97**, xxxvi–lv (1941); "Geology and the Community", NATURE, **147**, 459 (1941). Read, H. H., "Geology and Geologists in the National War Effort", NATURE, **149**, 39 (1942); "Geologists in War Time", NATURE, **149**, 282 (1942); "Geology, Geologists and the War Effort", NATURE, **151**, 118 (1943); "Co-operation in Scientific Research in the British Empire", NATURE, **152**, 29 (1943). Bailey, E. B., "Geology in the War and After", NATURE, **152**, 728 (1943).

* *Abstr. Proc. Geol. Soc.*, No. 1399, 11 (Dec. 28, 1943).

mining and geological sections are combined under a non-technical director selected from the Administration Department. The mining community has never been satisfied with this arrangement nor has the geological section received the support and encouragement it merits. A great lack of uniformity of conditions prevails throughout the Colonies undertaking geological work, notwithstanding the existence of a professedly unified Colonial Geological Service.

"Water-supply investigation suffers from a wide divergence of control in the different Colonies and even a lack of consistent policy within a particular Colony. Thus at one period as many as six departments were engaged independently upon water-supply. The present policy, in general, is to use the Geological Survey to direct these activities, although in one Dependency control has recently been removed, first to the Railway Department and then to the Public Works.

"The temporary or intermittent character of some Geological Surveys, though often the result of varying financial conditions, is also partly attributable to this ignorance of the practical value of geological work. In British Guiana, Jamaica, Nyasaland, Tanganyika, and elsewhere geological work has been intermittent and the gaps have seriously retarded the systematic survey of these territories. In consequence, when certain economic demands arose, there was a lack of preparedness to meet them. Some countries, like Fiji, have never had a Geological Survey, while in others, like Kenya, there was undue delay in establishing one.

"This complete misconception of the purpose and results of geological work is also exemplified in the use of geologists for duties other than those for which they have been trained and which they are engaged to undertake: for example, the using of a geologist as an Inspector of Mines, as a District Commissioner or as an Agricultural Officer, and the overloading of him with routine clerical work or with an undue amount of topographical survey.

"A number of examples might be quoted in which the failure to obtain geological advice upon engineering problems, such as railways, bridge and dam sites, has been very costly, both financially and in the consequent interference with public services.

"A lack of continuity of policy regarding long-range systematic geological work has resulted in a lack of balance whereby an undue amount of attention has at times been given to one branch of survey work at the expense of other equally important branches."

Sir Edmund gave the accompanying statistics of the amount and value of the mineral production of the Colonial Empire.

Table 1 is of particular interest, since it shows the revenue accruing directly to the Colonial authorities through the exploitation of mineral deposits actually discovered by Colonial Geological Surveys. Sir Edmund pointed out that, while the total royalties received from the diamond industry alone in the Gold Coast, up to 1939, amount to £424,830, the annual expenditure on geological survey is only £7,000. In other words, this royalty alone would pay for the cost of the survey for sixty years. In the Colony and Protectorate of Sierra Leone the discrepancy, he stated, is even more striking. The Colony at present employs only one geologist, but the estimated value of the mineral production was more than 1½ million pounds, providing a direct revenue to the Colony of nearly £175,000.

TABLE 1.—PRODUCTION AND VALUE OF CERTAIN MINERALS RESULTING FROM THE DISCOVERIES OF COLONIAL GEOLOGICAL SURVEYS[1].

Mineral	*Production*	*Value*	*Royalty*	*Remarks*
		GOLD COAST		
Diamond	14,139,683 carats	£7,613,186	£424,830	Production represents exports to end of March 1939. Diamond export tax to end of December, 1939.
Manganese ore	5,341,308 tons	£10,062,594	—	Manganese ore is wet ore for the earlier years and dry ore for later years.
		SIERRA LEONE		
Iron ore	2,750,000 tons	£1,497,373[2]	—	Diamond profit tax 1935 to 1938.
Diamond	2,616,104 carats	£3,275,402[2]	£466,818	Quantity refers to production, value to exports. Values of production not available, but should not vary greatly from exports.
		NIGERIA		
Coal	5,546,000 tons	£1,860,000	—	To end of March, 1939. Coal mining being a Government industry, the value refers to expenses incurred in mining, no profit being added.

ESTIMATED RESERVES, NO PRODUCTION YET

GOLD COAST	Bauxite	250,000,000 tons.
NYASALAND	Bauxite	60,000,000 tons.

[1] Information supplied by the Mineral Resources Department of the Imperial Institute. Figures are cumulative from the earliest recorded production or export. Later figures are not generally available for publication.

[2] To end of 1940: iron ore £2,640,966; diamond £4,700,272.

TABLE 2. VALUE OF MINERAL PRODUCTION (IN £ STERLING) OF CERTAIN BRITISH COLONIES AND DEPENDENCIES DURING 1938.

Country	*Value*	*Principal Minerals with their Values*
Nigeria	2,100,000	Tin 1,685,000; gold 177,000; coal 180,000.
Gold Coast	6,267,000	Gold 4,811,000; manganese ore 908,000; diamond 548,000.
Sierra Leone	1,684,240	Diamond 818,925; iron ore 646,421; gold 216,793.
Kenya	633,388	Gold 499,601; soda 132,878.
Uganda	226,690	Gold 146,286; tin 78,483.
Tanganyika	712,730	Gold 588,679.
Northern Rhodesia	10,683,715	Copper 10,254,705.
Aden	120,971	Salt.
Ceylon	131,231	Graphite; excludes salt.
Palestine	330,000	Potash and bromine.
British Malaya	9,970,000	Tin 7,980,000; iron ore 920,000.
British Borneo (Brunei, Sarawak)	980,000	Petroleum 830,000; gold 130,000.
New Guinea (year June 1939)	1,700,000	Gold.
Fiji	632,000	Gold.
Trinidad and Tobago	2,765,680	Petroleum 2,654,492.
British Guiana	697,800	Bauxite 395,190; gold 226,337; diamond 74,273.

The information given above was supplied by the Mineral Resources Department of the Imperial Institute. Quarry products and salt are, in general, excluded. The following additional statistics have been derived from other sources.

Cyprus	1,495,000	Cupreous pyrite and concentrates 1,257,000, asbestos 88,291.
Ocean and Nauru Islands	850,000 (estimated)	Phosphates.
Bahrein Islands	2,050,000 (estimated)	Petroleum.
	44,030,435	

There was also a small production in other Colonies: for example, Bechuanaland (gold), Somaliland (salt), Swaziland (asbestos, gold), Papua (gold), Turks and Caicos Islands (salt).

These figures are but examples, and ignore the actual or potential value of Geological Surveys in other directions, notably in matters of water supply, a theme which Sir Edmund elaborated at some length. He stated that "Those who have not lived and worked in the tropical Dependencies do not, perhaps, realize the extent of country that suffers from the handicap of uncertain and seasonal rainfall. . . . Geological advice can in many cases provide a remedy and thus assist in a better distribution of the population and in the development of unused tracts of land."

As an example of one of the more indirect results of a Geological Survey, he remarked that in Nigeria the discovery of a coalfield resulted in the building of a direct railway linking the tin-fields with the coast and in the development of one of the best deep-water harbours in West Africa.

Referring to the Colonies of the British Empire as a whole, Sir Edmund said that "in very few cases has detailed systematic mapping of the standard adopted in Great Britain been attempted, and even in the countries with the strongest and longest established Surveys it can safely be asserted that the greater proportion of the geology shown on the published provisional geological maps is based on reconnaissance traverses. Shortage of staff and the absence of reliable topographical maps are two factors which have handicapped progress in systematic mapping. At the most, fewer than fifty geologists have been available, and at certain periods very many fewer, to deal with an area of about three million square miles—some thirty times the area of the Home Country. Compare this with the staff of over 5,000 trained geologists provided by the Soviet Government !" and, it may be added, with the fifty or so employed in Great Britain alone. As Sir Edmund remarked, the amount of money devoted to Colonial Geological Surveys is astoundingly insignificant in comparison with the benefits they have conferred upon the Empire. Accurate figures are not available, but they probably represent something of the order of a decimal of 1 per cent of the value of the mineral production.

The later part of Sir Edmund's address dealt with certain recommendations, put forward by members of the Institution of Mining and Metallurgy and fellows of the Geological Society, for securing for the Geological Surveys their rightful place in post-war Colonial development.

The meeting was then thrown open for general discussion, and a number of written contributions to the debate were received.

Sir Lewis Fermor, who spoke at some length, pointed out that the total area under the control of the Colonial Office is much smaller than Canada, and only of the same order of magnitude as the Indian Empire. Both these countries have found it advantageous to have unified Geological Surveys, yet each Colony, no matter how small, has its own Survey, or none at all; and this in spite of the fact that some of the Colonies occupy contiguous areas. He also directed attention to the fact that each Colony, no matter whether rich or poor, has to finance its own survey. This fact, combined with the lack of central co-ordination of the work of the several surveys, results in Colonial geological departments varying widely in size, whether expressed by number of personnel or the number of geologists per unit of area, and also in the salaries offered to geologists. Such conditions form a stumbling-block in the way of unifying the Colonial geological services. He suggested the grouping of the Colonies into larger units for geological purposes, and the establishment of a system whereby the emoluments of geologists were not directly related to the ability or otherwise of any particular Colony to pay an adequate salary. A move in this direction, he claimed, especially if it carried with it possibilities of promotion with transfer to other Colonies, would lead to an improvement in the morale of Colonial geological officers. It would also benefit not merely the officers concerned but, ultimately, the Colonies themselves.

A number of other points were raised during the course of the debate. One speaker directed attention to the tendency for the more ambitious and energetic geologists to leave government service to work for private mining companies, where better treatment and higher salaries were received; and another instanced the case of a highly successful Canadian mining company that thought it worth while to employ more geologists on its staff than the total number of government geologists in all our African Colonies.

A later speaker mentioned the Island of Trinidad, which, in spite of its valuable oil resources, has not been subjected to a general geological survey since 1860. As a consequence, when, during the present War, it became a base for American forces, and the question of water supplies for the northern part of the land arose, the Colonial authorities had no government geologist to advise them and had to turn for aid to the oil geologists. It was pointed out that the lack of a single government geological report on the geology of the oilfields there within the last thirty years indicated the lack of interest taken by the Colonial Department in these matters.

Sir Thomas Holland, in a written communication, made the following points. He disposed of the suggestion that the geological mapping of the Colonies might be nearing completion by pointing out that so long as geological science continues to progress and specialize, the geological map will never be finished. So long as mineral values continue to change, as they have done in the past, and no doubt will in the future, for a variety of reasons, so often, too, will parts of the geological map need revision. Sir Thomas also directed attention to the desirability that the information accumulated during the course of the Colonial Geological Surveys should be published in some systematic and organized way, so that it might become readily accessible to the outside geological world for reference and, if necessary, criticism.

Another speaker mentioned the importance of geophysical prospecting as an essential adjunct to a Geological Survey. This, he claimed, is insufficiently recognized, and Colonial Surveys should be adequately equipped in this respect, both instrumentally and in respect of suitably trained staff.

Another contributor to the debate made an eminently practical and valuable suggestion in connexion with the possibilities of air survey in the development of the Colonies. He mentioned that the R.A.F. has accumulated a large staff, highly trained in the modern technique of air photography, and in the interpretation of air photographs, the use of which in prospecting and the interpretation of geological structure is well recognized; in passing, it may be mentioned that a number of geologists are actually employed on this staff. It is incumbent on the Government, he suggested, and in particular the Colonial Office, when the War ends, to secure the service of these expert technicians and their

equipment for use in the development of the Colonies.

At the conclusion of the meeting the following resolutions were proposed and carried unanimously:

(1) That this Joint Meeting of the Geological Society of London and of the Institution of Mining and Metallurgy welcomes the attention now being given to the resources of the Colonial Empire and desires to stress the importance of Geological Surveys in the well-being of the Colonies, especially for the development of mineral resources and in connexion with water supply, public works, soil conservation, agriculture and forestry.

(2) That this Meeting views with concern the progressive deterioration of status of certain Colonial Geological Surveys and the discouraging conditions under which these Surveys are now functioning. It is also of opinion that Colonial Government Departments do not fully appreciate the practical value of geology to the community and the need for maintaining the individuality of the Surveys, under the direction of competent and experienced geologists.

(3) That this Meeting advocates: (*a*) the appointment by the Colonial Office of a Colonial Geological Surveys Advisory Board, (*b*) the appointment to the staff of the Colonial Office in London of a scientific Director-General of Colonial Geological Surveys, who should report periodically to the Advisory Board and should inspect the work of the Colonial Geological Surveys from time to time.

(4) That this Meeting urges that the deputation appointed by the Councils of the Geological Society and the Institution of Mining and Metallurgy jointly should wait upon the Secretary of State for the Colonies and submit their views with the object of increasing the scope and fostering the welfare of the Colonial Geological Surveys as an essential part of the post-war development programme for the Colonial Empire.

We are informed that the proposed deputation has since been favourably received by the Secretary of State for the Colonies.

While it seems clear that the action taken was well justified, in fairness to the Colonial Office it should be stated that a certain amount of attention has recently been given to the matter. Following on the passing, in 1940, of the Colonial Development and Welfare Act, a Colonial Research Committee was appointed, in June 1942, to advise upon the expenditure of the annual sum of £500,000 provided by the Act of 1940 as provision for Colonial research, and to assist in co-ordinating the wh. le range of research in Colonial studies. This Committee recently published its first progress report (see NATURE, **153**, 119; 1944). In this report it is pointed out that Geological Surveys would come within the Committee's purview, and it is also noted that they do not at present exist in certain Colonies. The Committee further directs attention to the fact that mineral development of Colonies is impossible without accurate topographical surveys. A grant of £7,000 to enable the Geological Survey of British Guiana to be carried on on a proper basis is recorded in this report; and, according to *The Times* of December 31, 1943, a further grant of £32,000 has been made for geological survey work in Nigeria.

The timely action taken by the Geological Society and the Institution of Mining and Metallurgy will, no doubt, serve a useful purp se in impressing on the Committee the urgent need for further action in this direction.

V. A. EYLES.

CANCER RESEARCH IN BRITAIN DURING 1942–1943

THE twentieth annual report of the British Empire Cancer Campaign was presented recently at a meeting in London. In proposing the adoption of the report, Prof. E. C. Dodds dealt in a general way with the difficulties of presenting the results of scientific research on cancer to the public, and with the complexity of modern experimental biology. He made particular reference to the success obtained in the treatment of cancer of the prostate with synthetic œstrogens.

Clinical

Recently American clinicians have obtained good results in the treatment of cancer of the prostate with œstrogenic substances. Similar results have now been seen in Great Britain. In one case treated at the Middlesex Hospital, the results of the American observers have been completely confirmed in the twelve months that the patient has been under treatment. Seven cases have been treated with diethyl stilbœstrol at the Royal Cancer Hospital by Dr. J. Watkinson, in collaboration with members of the honorary staff. In five of these cases there was evidence of secondary deposits in bone and an increase in the acid phosphatase in the blood serum. In these five cases the treatment produced some regression of the primary growth, a fall in the serum acid phosphatase and a reduction in the pain due to metastases. In one patient regression of a lymph node deposit was observed. Two cases appeared to derive no benefit from the treatment, but on the whole the work is most promising.

The Clinical Cancer Research Committee gives an analysis of details of more than a thousand cases of intrathoracic cancer. The analysis in general is in agreement with existing knowledge. The incidence is high among painters, decorators, engineers and mechanics. It is low among clerks and typists. Although 74 per cent of the patients consulted a doctor within three months of the onset of symptoms, 90 per cent died within a year of the time when diagnosis was made.

Experience gained with the million-volt X-ray installation at St. Bartholomew's Hospital indicates that high-voltage therapy is particularly effective in the treatment of cancer of the rectum.

Carcinogenic Agents

Workers at the Royal Cancer Hospital have found that 1 : 2′-diamino 1′ : 2-dinaphthyl, which inhibits growth but has not produced tumours at the site of injection or application, induces multiple adenomas of the lung in mice. The substance thus has a remote carcinogenic action. Russian and French workers have obtained tumours in mice remote from the site of injection of extracts of human lung and liver. Many tumours have occurred at the site of injection of extracts of human organs, but such tumours have generally appeared at least twelve months after the beginning of treatment. The agents present in human organs appear to be weak and slow in action. As yet it has been impossible to ascertain before test whether a particular organ will give a carcinogenic extract, so that progress in this field has been slow.

Prof. H. N. Green and Dr. F. Bielschowsky have made further studies on the action of the carcinogenic insecticide, 2-acetylaminofluorene. When fed to male rats, this substance produces tumours of the liver

similar to those produced by 'butter yellow'. In female rats, it produces adenocarcinomas of the breast, although the substance itself does not appear to be œstrogenic. No other insecticides or phenothiazine derivatives have been found to have carcinogenic activity, but phenothiazone is toxic when fed in small amounts over a long period.

3 : 4-Benzpyrene was first isolated from coal tar ten years ago. Dr. I. Berenblum and Dr. R. Schoental, of Oxford, have recently investigated the carcinogenicity of fractions of coal tar separated by chromatographic methods. They find that the fraction containing the benzpyrene is less active than certain other fractions in producing cancer on the skin of mice and rabbits. American workers during the past year have published results showing that although benzpyrene is rapid in its action, the dose required to induce tumours in mice is much larger than the corresponding dose of 1 : 2 : 5 : 6-dibenzanthracene (W. R. Bryan and M. B. Shimkin, *J. Nat. Cancer Inst.*, 3, 503 ; 1943). In attempts to obtain new types of tumours in fowls at the Glasgow Royal Cancer Hospital, injections of benzpyrene and methylcholanthrene have failed to produce tumours. On the other hand, many tumours have been induced in chickens with dibenzanthracene. Experiments carried out at Sheffield suggest that cats are resistant to the action of benzpyrene and methylcholanthrene.

Dr. J. W. Orr has applied methylcholanthrene to the nostrils of mice from a strain (I.F.S.) in which breast tumours do not normally occur. No lung tumours were found, but of twenty-nine female mice treated in this way eighteen developed mammary cancer.

Metabolism of Carcinogenic Hydrocarbons

Dr. I. Berenblum and Dr. R. Schoental, working at Oxford, have found that benzpyrene is converted into 8-hydroxybenzpyrene, and that 1 : 2-benzanthracene is converted into 4'hydroxy 1 : 2-benzanthracene in the intestinal tracts of mice and rats. These phenolic substances which are formed are not carcinogenic. The Oxford workers have collaborated with scientific workers of the Royal Cancer Hospital in studying the growth-inhibiting power of these metabolism products and their derivatives. The metabolism products themselves have no growth-inhibiting activity, although some hydroxy derivatives, such as 4'hydroxybenzpyrene, are active growth-inhibitors. Some methyl derivatives of the metabolism products can inhibit the growth of tumours. The active substances of this type are all monomethoxy compounds, such as 4'methoxy 1 : 2-benzanthracene and 8-methoxy benzpyrene. The dimethoxy derivatives of carcinogenic hydrocarbons appear to be devoid of growth-inhibiting activity.

Bone Tumours in Mice

Some years ago Mr. F. C. Pybus and Dr. E. W. Miller of Newcastle-upon-Tyne developed a strain of mice in which bone tumours including sarcomas frequently occurred. In 1936, about one quarter of the mice which died had palpable osteomata or sarcomata, but since then the incidence of bone tumours has declined although the mice have been inbred. Over a ten-year period 21 per cent of females and 7 per cent of males of this strain died with bone tumours. The difference in incidence in the sexes suggests that œstrone might have some influence on the development of these tumours. Dr. J. W. Orr has studied the effect of œstrone on the histology of the bones of mice. The bones of female mice of this 'Newcastle bone tumour' strain are unusual in that there is a considerable amount of medullary bone and a mosaic appearance in the cortex. The bones of spayed females of this strain resemble those of normal mice. Treatment of mice of other strains with œstrone causes osteoclastic changes, including both resorption and production of bone. The mice of the Newcastle bone tumour strain are exceptionally susceptible to the action of œstrone. A sex hormone, in addition to other unknown factors, probably plays some part in causing the bone tumours that are found in this special strain of mice.

Filterable Agents

Experiments carried out at the Middlesex Hospital show that injection of either proflavine or 5-aminoacridine into the breast tissue will localize the Rous sarcoma virus. The localization of the virus leads to the formation of a tumour at the site of injection of the acridines. Kieselguhr is a localizing agent, but is much less effective than the acridine compounds. Methylcholanthrene is a very feeble localizing agent. The effect is probably governed by the type of tissue reaction resulting from the injection. The acridine compounds have a mild toxic action and cause proliferation of muscle nuclei.

Only a few of the topics dealt with in the report have been mentioned, but it is clear that progress has been made in the face of difficulties and many new facts have been brought to light during the year under review. With its coming of age, the British Empire Cancer Campaign is to be thanked for the way it has raised funds to support cancer research and for the care with which it has organized and correlated the efforts of many scientific men working in fields directly and indirectly bearing on the subject.

E. BOYLAND.

GYROSCOPIC PRINCIPLES AND APPLICATIONS

GYROSCOPY, since it belongs to classical mechanics, tends to be neglected by the modern physicist. We have now to depend on the engineers and applied physicists to maintain the teaching of the subject. Its applications cannot be ignored; in the development of modern applied science we find many extremely important applications of gyroscopes; and in the increased use of bodies rotating at angular speeds that are being continually increased from year to year, we find gyroscopic effects that must be taken into account in the design of the supporting structure whenever the rotating body, whether it be engine, wheel or propeller, has the direction of its axis of spin altered. When a motor-car turns to the left, the spin of the engine causes a transfer of load from rear axle to front axle, and the spin of the wheels gives a transfer of load from inner to outer wheels. When a single-engined aeroplane turns to the left, the nose tends to dip ; when the turn is to the right, the gyroscopic effect tends to raise the nose. When a twin-engined plane, with propellers turning in opposite directions, alters course, the leading edge of one wing tends to dip and the leading edge of the other tends to rise, so that additional stresses on the structure are intro-

duced. Jet propulsion will lead to the removal of the gyroscopic action of the propellers, and perhaps also to the removal of much of the gyroscopic action of the engines.

The subject is a difficult one; the mathematical treatment is not easy, and the translation of the mathematical results into application requires the powers of both mathematician and engineer. Prof. C. E. Inglis has both qualifications, and in the thirtieth Thomas Hawksley Lecture to the Institution of Mechanical Engineers*, he has given an excellent account of the theory of gyroscopy, and has detailed several practical demonstrations and applications, some new, all interesting. Usually the subject is approached from the idea of angular momentum, and the couple required to change the direction of this vector quantity. Prof. Inglis begins in a simpler way: if a point P is travelling with a speed v along a radius vector rotating with angular speed Ω, then P must have an acceleration $2v\Omega$ in a direction perpendicular to the radius vector. If now a gyroscope is spinning about a horizontal axis, and is being forced to precess about a vertical axis, every point in the upper half of the gyroscope requires an acceleration in a direction parallel to the axis of spin, and every point in the lower half requires an acceleration in the opposite direction. Hence the precession of the gyroscope about a vertical axis requires a couple about a horizontal axis perpendicular to the axis of spin. The simple working rule follows, that the axis of spin tends to turn towards the axis of the applied couple.

Excellent demonstrations by Prof. Inglis illustrate these points. A belt is running with velocity v between two vertical pulley wheels mounted on a horizontal platform that can rotate about a central vertical axis with uniform angular velocity Ω. Each horizontal part of the belt has to develop a horizontal acceleration $2v\Omega$, so that there is a transverse parabolic bowing of the belt, the upper part to one side, the lower part to the other side. A second demonstration of the same effect is given by means of a gyroscope, the disk of which is composed of several layers of paper. If the axis of spin of the gyroscope is horizontal, and the axis of the applied couple is vertical, the disk becomes warped about a horizontal axis perpendicular to the other two axes, and not about the axis of the applied couple.

In the next demonstration, a gyroscope spins about a horizontal axis, its axial supports being carried by a frame that is free to rotate, about a horizontal axis perpendicular to the axis of spin, in a second frame that is free to rotate about a vertical axis. A couple is applied, by means of a weight suspended from a point in the first frame, on the axis of spin produced. The axis of spin remains horizontal, but the gyroscope precesses about a vertical axis. In the demonstration, the gyroscope was a powerful one, of polar moment of inertia 25 lb.-ft.^{2} and of angular speed 3,000 r.p.m., and the couple of 150 lb.-ft. was produced by the weight of a man suspended at a point one foot from the centre point of the gyroscope; the man was carried through a complete rotation about a vertical axis in about $10\frac{1}{2}$ seconds. Hurrying the precession raised the man, retarding the precession lowered him. When the precessing frame of such a gyroscope hits a stop and is brought to rest, the gyroscope begins to tilt over; a very considerable couple is developed tending to remove the resistance to precession; this couple reaches a maximum at a tilt of about 35°, and decreases to zero at a tilt of 90°.

The general equations of motion of a precessing gyroscope are worked out in a mathematical appendix, and several important deductions are made. The frequency of nutation, in which there is a periodic interchange of kinetic energy between tilting and precession, is deduced, and emphasis is laid on the importance, for great stability, of a high natural frequency. In the paper a description is given of a new form of gyroscopic vibration damper, originated by Dr. R. N. Arnold, by means of which excessive chatter in a heavy armour-plate planing machine has been suppressed, the frequency of the gyroscope being tuned to the frequency of the chatter, and suitable fluid damping being applied.

The gyroscopic action of a pair of wheels of a locomotive or motor-car when the vehicle is rounding a curve is worked out; the load transferred from inner rail to outer rail for a typical pair of locomotive wheels and axle moving in a typical railway curve is shown numerically to be negligible. It is also shown that if one of the pair of wheels drops through a small distance at a rail joint on a straight part of the line, the resulting precession about a vertical axis is by no means negligible, and the practical conclusion is drawn that rail joints should be placed side by side, and not staggered.

Gyroscopic stabilization of a monorail truck is considered very fully, both in a second mathematical appendix and in descriptions of arrangements that lead up to the Brennan monorail stabilizer. The gyroscopic ship-stabilizer and the gyrocompass are treated in as simple a manner as the subjects will permit. The paper concludes with an explanation of the stability of a spinning-top. Emphasis is given throughout to the principle, so valuable when appreciated and properly applied, that a spinning body can be given complete stability by hurrying the precession; the child's top rises to the sleeping vertical position because frictional forces at the peg hurry the precession; and the same principle leads directly to the realization of an artificial horizon for the navigator, and of a horizontal sighting platform for the bomb aimer. ROBERT C. GRAY.

* "Gyroscopic Principles and Applications". By Prof. C. E. Inglis. Being the Thirtieth Thomas Hawksley Lecture to the Institution of Mechanical Engineers, delivered on November 19, 1943. (Institution of Mechanical Engineers, Storey's Gate, London, W.C.1.)

OBITUARIES

Dr. H. A. Mess

HENRY A. MESS, reader in sociology in the University of London, whose death took place early in January, was one of the few men who have been fortunate enough to combine the academic life, which he loved, with very wide experience in the field of social administration. He came into the university world at a later age than is usual, but all his previous work was, in a sense, a preparation for his main interest and provided him with an inexhaustible supply of material on which to draw for his study of the structure of society.

Dr. Mess was born in 1884 in Stoke Newington and educated at Bancroft School, Woodford, but, owing to a decline in the family fortunes, he was not able to go to Oxford as he had hoped. While earning his living as a clerk in an insurance office, he attended evening classes and, in 1905, took first-class honours in modern languages as an external student of the

University of London. All his spare time was given to teaching literature at the Mansfield House University Settlement in Canning Town, where he found himself becoming so absorbed by the social problems of the neighbourhood that, in 1912, he became secretary to the Settlement, a post which he held until 1919. This experience coloured his whole life and determined his future work for, on removing to the Settlement, he was immediately plunged into the distress connected with a great dock strike, and his first book, "Casual Labour at the Docks" (1916), was based on material collected in Canning Town. The conditions with which he was brought into such close contact convinced him of the need for a careful study of social organization if any constructive reform was to be achieved, and this remained the chief preoccupation of his life.

Further experience, first as social studies secretary of the Student Christian Movement, later as lecturer in social science to the Lancashire and Yorkshire Congregational Union, gave Dr. Mess greater opportunities for gathering detailed knowledge of social conditions and, after a period at the London School of Economics during which he wrote his "Factory Legislation and Administration", he began the work which was to prove his most outstanding achievement. In 1925 he was appointed director of the Bureau for Social Research for Tyneside and later director of the Tyneside Council of Social Service, and for ten fruitful years he identified himself with the life of a region that was suffering all the incalculable misery of prolonged industrial depression. True to his belief in the need for greater knowledge, he was not content to initiate and foster innumerable efforts to preserve and develop the community life of the area; he also conducted a social survey, published as "Industrial Tyneside", which is a model of its kind.

In 1935 Dr. Mess was appointed reader in sociology at Bedford College (University of London), and for the first time had the leisure to devote himself more fully to research; but he was by no means cut off from other activities. He sat on many advisory bodies, acted as University Extension lecturer and gave many broadcasts, the most notable of which was a series of talks on "Social Groups in Modern England", which was later published in book form. In 1942 the College gave him part-time leave of absence to enable him to act as director of studies to the National Council of Social Service, and at the time of his death he was engaged in a number of extremely important inquiries, in which the combination of sociological technique with his wide knowledge of contemporary economic and social conditions was of inestimable value.

By temperament, Mess belonged to that breed of Nonconformist Liberal whose contribution to social reform in Great Britain has been so striking and, indeed, through his mother's family he had direct links with the early Independents. He was a sincere Christian with a profound belief in the dignity and powers of the common man, given the right social environment. It was from this faith that all his work drew its inspiration. As a sociologist, he was just beginning to see his way clear, and there is no doubt that, had he lived, his wide knowledge and humane sympathies would have enabled him to make a real contribution to this youngest of university disciplines. English sociologists can ill afford to lose so valuable a member of their small band.

GERTRUDE WILLIAMS.

Major H. J. L. Beadnell

HUGH JOHN LLEWELLYN BEADNELL died suddenly on January 2. He was born in 1874 and was educated at Cheltenham College, King's College (London) and the Royal College of Science. He had a long and vigorous career, and his name is linked above all with the geology and water resources of the Libyan Desert. He joined the Geological Survey of Egypt in 1896, and his early work included the geology of the Abu Roash dome near the Pyramids of Giza: soon, however, he was sent westward to the Libyan oases of Farafra, Dakhla, and Baharia, and then to the Faiyum. His report on the last of these was a remarkable achievement, and it provided a solid basis for the specialized work of those who followed more than twenty years later with advantages of transport and equipment which were unheard of in his day. From his Faiyum investigations, moreover, came the discovery, in which C. W. Andrews of the Natural History Museum shared, of the highly important Eocene and Oligocene mammalian remains (Eosiren, Moeritherium, Palæomastodon, Arsinoitherium and others) which are known to palæontologists throughout the world. In 1905 he investigated the relations of the Eocene and Cretaceous beds between Esna and Aswan, in Upper Egypt.

In 1906 Beadnell's interest in the Libyan oases took him into the scheme for the reclamation of Kharga oasis, and he left Egyptian Government service. He was concerned with this project, which did not realize expectations, until 1910, and he published the well-known book "An Egyptian Oasis" in 1909.

The next phase of his life was varied, and typical of him. He went ranching in British Columbia (1912–15), enlisted in the Artists Rifles in 1916, served with the Egyptian Expeditionary Force (1916–19), and completed his service with the acting rank of lieutenant-colonel: he was mentioned in dispatches and received the Order of the Nile. After the War he was engaged in the search for oil, was surveying in Central Sinai and on the Red Sea coast during 1921–25 (in Egyptian Government service once more) and wrote "The Geology of the Red Sea Coast between Qoseir and Wadi Ranga" (Petroleum Research Bulletin No. 13, 1924). Two years later his delightful book "The Wilderness of Sinai" was published.

In 1927 Beadnell returned to official work in the Libyan Desert and for two years he was actively employed, especially with the work on wells in remote parts of the desert. Too little has been written of what he achieved in those two years and in his last period in the Libyan Desert, during 1930–32, when he was resident engineer of the Qattara Depression hydro-electric project of the Egyptian Government. The scheme aimed at running water from the Mediterranean to turbines at a site below sea-level in the depression.

From about 1932 Beadnell was seriously ill and spent much of his time in London: active still, he maintained his lifelong interests and took up gemmology. His last years were clouded by the death of one of his two daughters, then of his wife, who had been his companion since the early days in Egypt (they married in 1904). In 1940 he was engaged by the War Office with the rank of temporary major in the Royal Engineers, which he held at the time of his death.

In addition to his two books and to his official

reports, Beadnell contributed to scientific publications, and especially to the *Geographical Journal*. He was awarded the Barlow-Jameson Fund of the Geological Society of London in 1904 and received the Cuthbert Peak Grant of the Royal Geographical Society in 1931. K. S. SANDFORD.

Dr. Birkett Wylam

BIRKETT WYLAM, chief inspector for Scotland under the Alkali, &c., Works Regulation Act and Rivers Pollution Prevention Acts, died suddenly at his home in Edinburgh on January 15. While Dr. Wylam had not been in his usual vigorous health for some time, the news of his untimely death came as a shock to his many professional friends.

A native of County Durham, Dr. Wylam was a graduate of the University of Durham, where he took the degrees of B.Sc. in 1921, M.Sc. in 1922 and Ph.D. in 1925. He became an associate of the Royal Institute of Chemistry in 1924 and was elected to the fellowship in 1935. He was an active member of the Council of the Institute during 1938–40, and was a prominent figure in the Edinburgh Section, of which he was chairman. He also took an active interest in the Society of Chemical Industry. In 1936 he became a member of the Institution of Chemical Engineers.

Dr. Wylam began his professional career as research chemist to Morton Sundour Fabrics, Ltd., and later was research chemist and process manager at Scottish Dyes, Ltd. (I.C.I.), Grangemouth. He left this post to take up his official duties with the Department of Health for Scotland in 1931. During the War of 1914–18 he served with the Royal Garrison Artillery in France.

I have been privileged to know Dr. Wylam for some eight years, during the last five of which I have been his colleague. He was a delightful person to work with, always thorough, sympathetic and helpful. He was a fair man, his standards were high, and he was incapable of being mean. His chief interest was in doing things, and an idea had no sooner crystallized in his mind than the machinery was set in motion to effect its realization. He never sought praise; it was sufficient for him to experience the pleasure of a job well done.

In his dealings with the chemical industry in the execution of his official duties he earned the respect of all as a competent chemical engineer, and he carried into this sphere his personal characteristics of fairness, high standards, and ever-readiness to help. For reasons of national security I cannot give details of his war-time activities; it is sufficient to say that his whole energy was directed into channels calculated to shorten the duration of the present conflict.

Dr. Wylam truly lived and enjoyed every moment of his life, at work, at home and at play. His hobbies were all constructive as well as artistic. He had a wide range of engineering and woodworking tools, which he put to no mean use. He was a keen photographer, a collector of commemorative medals, and a very wide reader. Science in Scotland has lost a man who, by virtue of his wide practical experience and acute mental alertness, was at his prime. To Mrs. Wylam and her children we offer our most sincere sympathy. JOHN HAMILTON.

WE regret to announce the following deaths:

Dr. L. H. Baekeland, the distinguished plastics chemist and inventor of 'Bakelite', on February 23, aged eighty.

Mr. H. H. Brindley, fellow of St. John's College, Cambridge, and during 1926–34 University demonstrator in zoology, on February 19, aged seventy-eight.

Prof. J. W. H. Eyre, emeritus professor of bacteriology in the University of London, on February 17, aged seventy-four.

Prof. Yandell Henderson, professor of applied physiology at Yale University, on February 18, aged seventy.

Mr. J. Reid Moir, F.R.S., president of the Ipswich Museum, on February 24, aged sixty-four.

Prof. H. F. Newall, F.R.S., emeritus professor of astrophysics in the University of Cambridge, on February 21, aged eighty-six.

Dr. E. O. Ulrich, formerly geologist in the U.S. Geological Survey, known for his work in invertebrate palæontology, aged eighty-seven.

Mr. S. E. Winbolt, formerly of Christ's Hospital, Horsham, who was an authority on Roman antiquities in Great Britain, on February 16, aged seventy-six.

NEWS and VIEWS

Edinburgh Medical Men and the Great Adventure

THE spirit of adventure as it has been exemplified by graduates of the University of Edinburgh was the theme selected by Prof. James Ritchie for his 'Promotor's' address at the Medical Graduation at the University of Edinburgh last July. It was, Prof. Ritchie pointed out, the Edinburgh medical graduate Mungo Park who discovered and traced the greater part of the course of the River Niger. Another medical student, Laing, discovered its source. Yet other Edinburgh medical men completed the Niger adventure, for Oudney discovered Lake Chad and Baikie led the last Niger expeditions sent out by the British Government. All these pioneers died in Africa. But, even before Park's day, men from the University of Edinburgh had been active in Africa. James Bruce re-discovered the sources of the Blue Nile, while Joseph Thomson, a pupil of T. H. Huxley, has been described as the last, and one of the most successful, of the great geographical pioneers in Africa. Other Edinburgh medical men have carried the spirit of adventure to geographical discoveries in India, Australia and America, and these men studied at the same time the natural history of the lands wherein they pioneered. On the seas the spirit of adventure is exemplified by Scoresby, the Whitby lad who became a world authority on the life of whales. To the Edinburgh naturalists Sir John Richardson, Harry Goodsir and John Macgillivray, the Franklin Arctic expedition owed much.

No doubt the graduates of Edinburgh or of other universities will be interested to learn that Edward Forbes, who founded the science of oceanography, left that University in his ninth year as a medical student without a degree, to return fourteen years later to do brilliant work as its professor of natural history. Wyville Thomson, another medical, also left without a degree, but because his health was not

good: twenty years later he became professor of natural history and planned and carried out the *Challenger* expedition. Another great oceanographer, Sir John Murray, continues the list of Edinburgh medicals who left without completing their degrees, a list which W. S. Bruce, who led the Scottish National Antarctic expedition, continues into the present century. Here is a record which will inspire the Edinburgh graduates of to-day, secure in the knowledge that they have got their degrees, to even greater achievements. As medical men they will do well to preserve in their minds Prof. Ritchie's reminder that there are Dark Continents of disease and suffering in all grades of modern society. The discovery, investigation and removal of these is especially the job of the modern medical man.

Mathematics as a Compulsory Examination Subject

MR. D. BROWNLIE, who is an organic chemist and chemical engineer, has published a pamphlet strongly advocating the abolition of compulsory mathematics in university matriculation examinations, even for degrees in engineering or science. He claims that "the very great majority of candidates, say about 90–95 per cent, have no particular aptitude in the subject of mathematics, which is almost universally detested. . . . Actually, mathematical proficiency above the normal is no indication of superior intelligence. . . . It would, in fact, not be difficult to make out quite a good case for the contention that in a considerable proportion of cases proficiency in mathematics is actually a sign of mental deficiency. . . . My experience with Euclid or geometry, or whatever it is now termed, had the natural result, as in the case of most other students, of regarding it as a pest to be learned by heart and forgotten completely as soon as the Matriculation examination was over." At a time like the present, when the educational system of Great Britain is being reconstructed, there is a place for a careful inquiry into the validity of the claims for the traditional subjects and methods of instruction. The use of wild and exaggerated language is not helpful in such an inquiry. A more useful step is the attempt, now being made by a committee representing all English School Certificate examining bodies and also the Mathematical Association, to provide an alternative course of mathematics, more closely allied to its applications, which can be followed by those who find the present school mathematics too abstract.

Refugees in Great Britain

POLITICAL AND ECONOMIC PLANNING (P E P) in a recent broadsheet (No. 216, January 14, 1944) gives a useful review of the present position of refugees in Britain and of the changes which have taken place during the War and since the appearance of Sir J. H. Simpson's report "The Refugee Problem" in 1939. The present number of civilian refugees is estimated at 139,430, including 50,000 Germans and Austrians, and 20,000 Allied seamen, a total which differs from that of the Prime Minister's statement of April 7, 1943, in allowing for those who have left or died since the beginning of the War. Considerable progress has been made in utilizing the services of aliens with special professional, technical or academic experience. According to the Minister of Labour's statement of September 23, 1943, shortly after the 1941 registration 82·5 per cent of the men and 60 per cent of the women were in employment, and since 1941 the opportunities open to aliens to engage in war-work have increased, so that the number who now remain unemployed is negligible.

The economic absorption of pre-war refugees has broken down their isolation, removed prejudices and enabled them to become acquainted with the British way of life. By and large, they have proved a valuable element in society: they have made contributions to the national life in industry, in the universities, in the arts and in science, and have acquitted themselves well during the War. The number of those who will wish to remain in Britain is estimated as roughly 40,000, a figure which is much smaller than in other countries before refugee emigration began in 1933. This number should be absorbed without difficulty after the War: a full employment policy for Great Britain should mean the disappearance of the refugee problem as we knew it before the War; but the refugees must be given a fair chance of sharing both the rights and obligations of British citizens.

Technological Museum of New South Wales

THE annual report of the curator of the Technological Museum of New South Wales for the year ended December 31, 1942, states that the scientific work of the Museum has been placed on a war footing without necessitating any reorganization of laboratory work. Chemical investigations of national importance have included the recovery of by-products from charcoal burning, dyeing of khaki cloth, preparation of coloured flashes and composition of flash powders and smoke screens from motor exhausts, fireproofing paper and 'Cellophane' gas respirators, Australian essential oils as mosquito repellents, rot-proofing of sandbags, strength of laminated plastics for aircraft, production of lactic acid and lactates from waste whey, and sources of quinine and similar alkaloids in Australia. Work has also been done on synthetic wax, fire-proofing fabrics for camouflage purposes, synthetic rubber from acetylene, production of drugs and natural dyes from Australian plants, camouflage materials, especially paint, wax from sugar-cane, and the relative humidity for controlling the development of moulds likely to attack silk parachutes in Queensland. Botanical investigations into the cultivation of the tung oil tree in Australia, as well as on suitable Australian fibres to relieve the shortage of imported material, and the important research on the cytology of the eucalypts and other genera, were continued. Much time has been devoted to the study of rot-proofing problems in the preservation of jute hessian, canvas and manilla, hemp and cotton rope and to the waterproofing and rot-proofing of canvas duck. Lists of lectures, etc., delivered, papers read before scientific societies, exhibits and publications are included.

Performance of Generating Plant

A PAPER read in London on February 3 before the Institution of Electrical Engineers by R. W. Biles and G. W. Maxfield reviews the performance of a group of generating stations over a five-year period, commenting upon coal qualities, thermal efficiency, analysis of the different classes of breakdown with deductions as to probable operating life between breakdowns, plant availability and the effects of loading. The plant under review is divided into three groups: pre-1930, 1930–1937 and 1938–1942.

From the results, curves for maximum probable availability are deduced. The suggestion is made that 'operating efficiency' should be calculated on a uniform basis and included in station records. The need for an overall standard by which the performance of generating stations can be judged is discussed, and the term 'standard merit', based upon operating efficiency and plant availability, is suggested.

It is concluded from the analysis that pre-1930 plant should not be operated at above 45 per cent average running plant load-factor if good availability is to be consistently maintained; marked improvements are to be noted in availability of the most recent plant installed since 1938 at 80 per cent average running plant load-factor; the lower breakdown rate per plant item of the pre-1930 group is notable when compared with that of the later plant groups. Good quality and grading of fuel supplies are needed, particularly for the pre-1930 plant, if maximum outputs are to be obtained. With larger units of plant, greater outputs between breakdowns have been possible: but it is not safe to conclude that larger units still would be to the general benefit of the supply industry. Size of unit required is related to the load curves and security needs.

Economic Rating of Motors and Transformers

IN a paper read by Mr. D. J. Bolton before the Institution of Electrical Engineers on December 2, physical and economic ratings of motors and transformers respectively are compared, and the scope and limits of economic choice are discussed and illustrated. A method of economic selection is proposed through the use of larger standard machines, and a technique is developed for investigating the economy of changes in rating. Tables of data and results are given at the end of the paper, and the methods employed in these tables are explained in some detail. The results are expressed in the form of an 'economic advantage' obtainable through under-running or over-running, and show the former to be highly advantageous in a large number of cases. Methods of implementing the results are discussed.

Canadian Mortality in War Years

ACCORDING to an annotation in the September issue of the *Statistical Bulletin*, the health of the Canadian people has remained at a very favourable level during the four years of the present War, the mortality in this period being the lowest on record. The improvement in mortality has been particularly marked in the diseases most prevalent among the young. Not only has the death-rate decreased among the communicable diseases of childhood, but also there has been an increased fall in the mortality among the large number of young adults in training camps. Diarrhœa and enteritis, which have always been important causes of death among Canadian children, have also shown considerable improvement in recent years. The rate of decline in tuberculosis is illustrated by a new minimum of 47·1 per 100,000, which is about one fifth below that for the period 1934–36. In contrast with the catastrophic influenza epidemic towards the close of the War of 1914–18, there has so far been no cause for serious concern, although there was a mild epidemic of influenza in Canada late in 1940 and early the following year, the favourable result being mainly due to the use of serum and chemotherapy in the treatment of pneumonia. Chemotherapy has also succeeded in reducing the mortality from appendicitis and the diseases incidental to child-bearing. On the other hand, there has been an increase in the mortality from cancer, diabetes, diseases of the heart and arteries, and from accidents.

Announcements

PROF. A. R. TODD, Sir Samuel Hall professor of chemistry in the University of Manchester, has been appointed professor of organic chemistry in the University of Cambridge.

PROF. ANTON J. CARLSON, chairman of the Department of Physiology in the University of Chicago, has been elected president of the American Association for the Advancement of Science.

THE title of professor emeritus of bacteriology in the University of London has been conferred on Sir John Ledingham, on his retirement from the professorship of bacteriology at the Lister Institute of Preventive Medicine. The degree of D.Sc. has been conferred on Mr. B. Prasad (University College), Dr. E. C. Barton-Wright (Birkbeck College and Chelsea Polytechnic), Mr. A. G. McDonnell Weddell (St. Bartholomew's Hospital Medical College), and Mr. George King.

THE Edison Medal for 1943 of the American Institute of Electrical Engineers, one of the highest honours in the field of electrical science and engineering, has been awarded to Dr. Vannevar Bush, president of the Carnegie Institution of Washington and director of the Office of Scientific Research and Development of the U.S. Office of Emergency Management, "for his contribution to the advancement of electrical engineering, particularly through the development of new applications of mathematics to engineering problems, and for his eminent service to the nation in guiding the war research program". Dr. Bush has also just received the Holly Medal of the American Society of Mechanical Engineers, for his work as a leader of engineering education and in scientific research, and in particular for his work on calculating machines.

OWING to the generosity of the Rockefeller Foundation of New York, which has for the fourth year in succession provided a grant for the purpose, the Royal Society is in a position to give some assistance to scientific societies and associations which, as a result of war conditions, are experiencing financial difficulties in the publication of scientific journals.

THE following appointments to the Colonial Service have recently been made: E. Dixon to be veterinary officer, Nigeria; W. J. J. Filkins to be physiological laboratory superintendent, Uganda; J. S. Groome to be forest officer (temporary), Tanganyika; G. W. P. Streeton to be deputy government chemist, Jamaica.

ERRATA.—We are asked by Dr. A. Hunter to make it clear that the experiments on exposure-time effects in photographic photometry attributed to him in NATURE of February 26, p. 242, were planned and carried out by Prof. W. M. H. Greaves, Astronomer Royal for Scotland. Furthermore, the microphotometers he described at the symposium give intensity traces direct, not merely density records, as stated.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

New Types of Optical Glass

IN view of the interest shown in new optical glasses recently produced in Great Britain and in the United States, we wish to summarize the present position and to indicate probable lines of development.

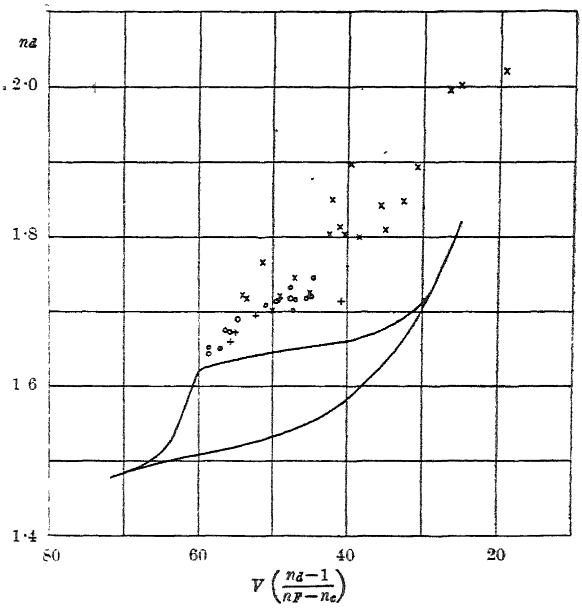
Advances in lens design have led to a demand for new glasses with optical properties different from those available hitherto as outlined in a recent paper by B. K. Johnson[1], who mentions glasses with high refractive index and low dispersion. Non-silicate glasses of this type containing rare earth oxides in high proportions and with optical properties ranging from 1·71 to 1·97 in refractive index and from 54 to 19 in V value have been described in the patent literature[2], but so far as we are aware, only one of them has been made available in Great Britain, namely, one with refractive index $nD = 1{\cdot}745$ and with $V = 45{\cdot}8$.

Examination of the well-known nD–V diagram for optical glasses shows that there is a large field for exploration, and it is desirable that the glass-maker should have some guidance as to the requirements for lenses of various types. On the other hand, without definite information that new glasses are available, the computer does not wish to spend time on designs which utilize optical properties for which there may be no corresponding glasses. It is our hope that this short account of new glasses developed by this Company will be of interest to designers and serve to stimulate experiments in lens design.

The new glasses contain appreciable quantities of silica and boric acid as the network formers, and their exceptional properties depend on the addition of the oxides of barium, lead, zinc and certain other metals. Their optical properties are plotted in the accompanying graph, and they lie between the limits of V value of 60 and 40 and have refractive indexes greater than $(1{\cdot}860 - 0{\cdot}004\,V)$. The American and some new German glasses[3] are included for comparison. The partial dispersions of the new glasses have not yet been determined for all the types, but it is interesting to note that the glass *SBF* 717480 has relative partial dispersions almost identical with those of the standard Telescope Flint 525512[4]. In the diagram, two bold circles indicate the main types on which production is concentrated. Other types not shown may be obtained by interpolation, but it is obviously advantageous to limit the number as there may be developments in another region in the nD–V diagram. The glasses are divided into two general types, those with V values greater than 55, being called Special Barium Crowns (*SBC*) and those with V values less than 55, Special Barium Flints (*SBF*).

The vitreous stability of the glasses, that is, their resistance to devitrification during melting, moulding and annealing, is as good as, or better than, that of the normal types of optical glass, and the compositions and melting technique are such that a high degree of homogeneity can be obtained.

Having regard to their extreme optical properties, the glasses can be considered as substantially free from colour, particularly those with high V value. The transmissions in the near ultra-violet (3650 A.) are generally higher than those for ordinary flints of the same index. Preliminary results indicate that their resistance to weathering is not less than that of normal flint glasses.



The curve encloses the area covered by Chance standard glasses. O, Chance silicate glasses. ×, Kodak glasses, U.S.P. 2150694 and 2206081; and B.P. 462304 and 534680. +, Schott glasses, U.S.P. 2297453.

The method of melting is by electric heating in platinum pots; Faraday seems to have been the first to use platinum crucibles in his classical experiments to produce homogeneous optical glass[5], followed later by Vernon Harcourt, but electricity was not then available to provide accurate control and application of temperature.

Owing to the chemical nature and high cost of the raw materials used, it is not possible to make the glasses on the scale of normal optical glass manufacture, and the process has been limited to small-scale meltings. The manufacture of optical glass on this scale to give freedom from striæ and bubbles has required the development of a new technique such as was not previously possible. The degree of control which can be exercised results in more closely repeatable properties than is possible with large-scale manufacture. While glass of useful size can be obtained on the present scale, the plant is undergoing development to enable larger meltings to be made.

The methods for the development of new glasses are now well established as a result of this work, and we would welcome the views of computers on requirements in optical design.

We have been encouraged to pursue this work by the active interest shown by the Admiralty and the other Service Departments, working through an Interdepartmental Committee under the chairmanship of the Director of Scientific Research, Admiralty.

W. M. HAMPTON.
R. E. BASTICK.
W. N. WHEAT.

Chance Brothers, Limited,
Glass Works, Smethwick. Jan. 31.

[1] Johnson, B. K., *Proc. Phys. Soc.*, **55**, 291 (1943).
[2] Brit. Pats. 462304 and 534680. U.S.P. 2150694 and 2206081. *J. Sci. Instr.*, **19**, 94 (1942).
[3] U.S.Pat. 2297453.
[4] See Chance-Parsons Optical Glass Catalogue.
[5] Bakerian Lecture, *Phil. Trans. Roy. Soc.*, **120**, 1 (1830).

Mathematics of Biological Assay

If in a biological assay the mean responses, y_{11}, y_{12}, of two groups of n animals to doses of a standard preparation the logarithms of which are x_{11}, x_{12}, are compared with the mean responses, y_{21}, y_{22}, to doses of the preparation under test the logarithms of which are x_{21}, x_{22}, it is often possible to express the relationship between dosage and response adequately by the equations:

$$Y_1 = a + bx, \qquad Y_2 = a + b(x - M), \qquad (1)$$

in which M is a constant difference between log-doses producing equal responses. It is usual to choose pairs of doses having a fixed ratio, so that $(x_{12} - x_{11}) = (x_{22} - x_{21}) = d$. Writing

$$R = \tfrac{1}{2}(y_{22} - y_{21} + y_{12} - y_{11}),$$
$$S = \tfrac{1}{2}(y_{22} + y_{21} - y_{12} - y_{11}),$$
$$\text{and } T = \tfrac{1}{2}(y_{22} - y_{21} - y_{12} + y_{11}),$$

it may be shown that M is estimated by

$$M = \tfrac{1}{2}(x_{22} + x_{21} - x_{12} - x_{11}) - Sd/R, \qquad (2)$$

since R/d is the estimated increase in response per unit increase in log-dose[1]. In a recent communication[2], E. C. Wood has shown that, if a quadratic term is added to the response curves, still keeping the condition that there shall be a constant ratio between equally effective doses, so that

$$Y_1 = a + bx + cx^2, \quad Y_2 = a + b(x - M) + c(x - M)^2, \quad (3)$$

equation (2) still estimates M.

It would be unfortunate if this interesting fact were allowed to conceal the limited applicability of the four-point assay. Equations (1) express the hypothesis that the responses are related to the log-doses by two parallel straight lines, and the data themselves provide a test of the adequacy of this hypothesis. T is a measure of the departure from parallelism of the straight lines connecting the responses to the pairs of doses; if s is the residual standard error in an analysis of variance of the responses by the $4n$ animals (differences corresponding to doses and to litters or any other relevant classification having been eliminated), the standard error of T, as also of R and S, is $s/\sqrt{n}$, and the significance of T may then be judged by a t-test.

Equations (3) express the hypothesis that the responses are related to the log-doses by quadratic curves, still with the condition that the curves are identical save for a constant ratio of potencies; the four parameters, a, b, c and M, may be determined so that equations (3) reproduce the experimental mean responses exactly, leaving no degrees of freedom for assessing the adequacy of the hypothesis. There may sometimes be strong *a priori* reasons for believing that the standard and test preparations have response curves of identical form, in spite of a difference in potency; a quadratic equation such as (3) may then be a sufficiently good approximation, even when a linear is unsatisfactory, and the relative potency is estimated as the antilogarithm of the expression in equation (2). Without this belief, it is unjustifiable to assume the existence of a constant relative potency, and the four-point assay cannot give a valid result unless a low value of T indicates the adequacy of the hypothesis expressed by equations (1). In all cases of uncertainty it is desirable to test at least three doses of both preparations, so that more information on the response curve may be obtained. Without such precautions, a spurious simplicity may appear in the results of an assay, a single figure being said to represent the potency of a test preparation relative to a standard, when, in fact, the relative potency depends on the level of response at which a comparison is made.

The standard error of M, as given by equation (2), is[1]

$$s_M = \pm \frac{sd}{R^2}\sqrt{\frac{R^2 + S^2}{n}}.$$

For any chosen level of probability a value of t may be obtained corresponding to the number of degrees of freedom on which s is based; provided that $g = t^2s^2/nR^2$ is small, the fiducial limits to M are $M \pm ts_M$, but when g is large the precise formula

$$M - \frac{g}{1-g}\frac{Sd}{R} \pm \frac{tsd}{R^2(1-g)}\sqrt{\frac{R^2(1-g) + S^2}{n}}$$

must be used.

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Feb. 4.

[1] Bliss, C. I., and Marks, H. P., *Quart. J. Pharm. Pharmacol.*, 11, 192 (1939).

[2] Wood, E. C., Nature, 153, 84 (1944).

Tautomerism of Cyanamide

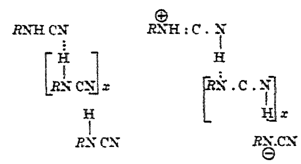
The constitution of cyanamide, since its first synthesis in 1851, has been the subject of a very large number of publications. Whereas the chemical properties of this substance point to the structures NH_2CN and $NH:C:NH$, its physical properties are held[1] to favour the former. The modern tendency is to regard cyanamide as a mixture of these isomers in tautomeric equilibrium[2], with the position of equilibrium considerably in favour of the cyanide structure.

The equilibrium $NH_2CN \rightleftharpoons NH:C:NH$ is a special case of amidine tautomerism, and the tautomeric behaviour of amidines has already been correlated[3] with their associated (hydrogen-bond) structure. Since many of the physical properties of cyanamide are consistent with a high degree of molecular association, it appeared of interest to examine the molecular condition of cyanamide and its N-substituted derivatives to see whether a similar correlation prevailed. A sufficient number of cyanamide derivatives has now been examined to provide overwhelming support for this suggestion, namely, that the tautomerism of cyanamide and its mono-substituted derivatives (RNHCN $\rightleftharpoons$ RN : C : NH) is due to their molecular association.

Molecular weight measurements have been made cryoscopically in benzene solution, or, in cases where the solubility was too low at the freezing point of benzene, in naphthalene. Cyanamide itself was not sufficiently soluble in either solvent to give reliable results, and was measured cryoscopically in nitrobenzene solution. In spite of the donor character of this solvent, and its consequent tendency to simplify the solute molecules, a 2 per cent solution of cyanamide in nitrobenzene showed an association factor of well over 2·0. Molecular weight determinations have been made on more than a dozen N-substituted cyanamides, which are found to fall into two distinct classes: those possessing an unsubstituted hydrogen atom (RNHCN) are markedly associated, their molecular weight rising rapidly with

increasing concentration, whereas those in which there is no free hydrogen (R_2NCN) are substantially unimolecular. It seems clear, then, that the former class owe their associated character no less than their tautomeric behaviour to molecular union through hydrogen bonds (N–H–N), the imino-hydrogen atom of one molecule being shared with the cyano-nitrogen atom of a second.

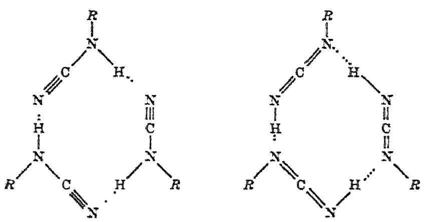
No conclusions can be drawn from the molecular weight evidence as to the type of associated molecules, for the molecular weight – concentration curves show little or no falling off in slope with increasing concentration. This may indicate linear polymers, and regarding the hydrogen bond as a resonance phenomenon[4], a linear polymer of the cyanamide RNHCN containing $x + 2$ molecules is depicted in Fig. 1, in which (a) and (b) are the unperturbed forms of the resonance hybrid.



(a) (b)

FIG. 1.

Cyclic polymers are not excluded, and a practically strainless trimer (Fig. 2) involves no separation of charges in the resonating forms (a) and (b).



(a) (b)

FIG. 2.

Chemical polymerization with formation of substances of the melamine type was, of course, excluded, the cyanamides being recoverable unchanged from the cryoscopic solvent.

Polymers such as those depicted above will possess all the properties attributed previously to the two tautomers RNH.CN and RN : C : NH, but since the polymeric resonance hybrid is neither of these, no separation of tautomers can be expected. Tautomerism owing its origin to resonance polymers of this kind has previously been named *mesohydric tautomerism*[5], and there seems little doubt that cyanamide and its monosubstituted derivatives provide further examples of this phenomenon.

A detailed account of these measurements will be published elsewhere.

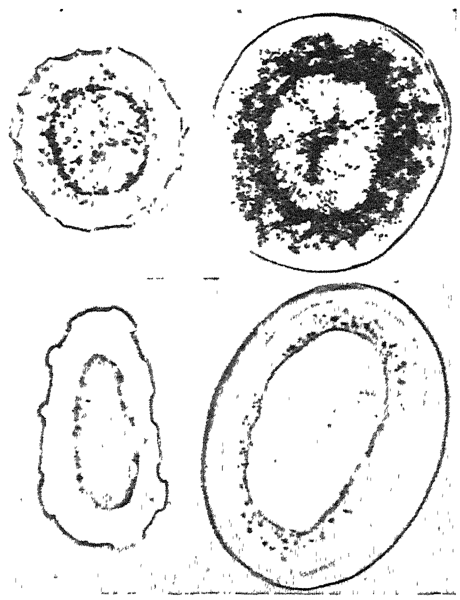
L. HUNTER.
H. A. REES.

University College and
City Boys' School,
Leicester.
Jan. 21.

[1] Colson, *J. Chem. Soc.*, 554 (1917).
[2] See Schmidt's "Textbook of Organic Chemistry" (trans. Rule, 3rd edn., 1936), 71.
[3] Hunter and Marriott, *J. Chem. Soc.*, 777 (1941).
[4] Sidgwick, *Ann. Rep. Chem. Soc.*, **30**, 112 (1933).
[5] Hunter, *Chem. and Ind.*, **60**, 32 (1941).

Morphology of Mammalian Hair

DURING a recent histological examination of keratin fibres, transverse sections were made through proximal, medial and distal portions of mammalian guard-hairs. The results obtained support earlier views upon the nature of hair growth[1,2]. Sections through proximal regions clearly demonstrated the alteration in fibre contour which follows upon changes in the hair follicle during the catagen phase. As atrophy of the hair root occurs, corresponding fibre shrinkage gives a characteristic irregular contour to the proximal region of the hair shaft. The accompanying reproduction illustrates the results obtained for guard-hairs from silver fox (*Canis vulpes fulva*) and kolinsky (*Mustela sibirica*).



ABOVE: *C. vulpes fulva*. PROXIMAL REGION (left). ×480. MEDIAL REGION (RIGHT). × 480.
BELOW: *M. sibirica*. PROXIMAL REGION (LEFT). × 650. MEDIAL REGION (RIGHT). × 380.

This variation in fibre contour is accompanied by changes in surface structure. Photomicrographic examination of cuticular-scale structure showed the presence of different scale types in the proximal and medial portions of guard-hairs; for example, kolinsky: proximal region, spinous type; medial region, irregular annular.

A detailed account of the investigation of hairs from members of Carnivora and Rodentia will appear elsewhere.

J. L. STOVES.

University, Leeds.
Jan. 25.

[1] Dry, J. W., *J. Genet.*, **16**, 287 (1925).
[2] Wildman, A. B., *Proc. Zool. Soc.*, 257 (1932).

Gamones from the Sperm of Sea Urchin and Salmon

Hartmann and Schartau[1] have introduced the term 'gamone' to denote substances which are carriers of the interactions between the gametes at the fertilization. Androgamones (A) are those carried by the sperm. Hartmann, Schartau and Wallenfels[2] separated two factors: A I is present in the methanol

extract of the sperm, whereas *A* II is insoluble in methanol. We have carried out some further studies on the androgamones from *Echinocardium cordatum, Psammechinus miliaris, Strongylocentrotus droebachiensis* and *Echinus esculentus.*

The undiluted sperm from the testes was frozen in carbon dioxide snow or in a mixture of this and acetone, and was dried in the frozen state by the 'Cryochem' method of Flosdorf and Mudd[3]. The dried sperm was extracted with methanol. The residue was suspended in sea water and subjected to a temperature of 85–90° for 3–5 minutes. The insoluble part was centrifuged off. A clear liquid was thus obtained. This contains *A* II, which precipitates and agglutinates the jellies. Electrophoresis of the solution after dialysis reveals only one component. The active substance migrates towards the anode at *p*H less than 4·0[4]. The active substance is precipitated by 75 per cent saturated ammonium sulphate.

The *A* II substance is very quickly inactivated by trypsin (in less than 5 minutes at 20° by 0·0025 per cent trypsin Merck). It is evidently a protein-like substance. Its molecular weight is probably less than 10,000[4]. It has even been autoclaved for 30 minutes at 1 kgm./cm.^{2} more than atmospheric pressure without loss of activity. It has a characteristic ultra-violet absorption band at or near 260 mμ. Jelly which has been brought into solution inactivates *A* II. Clupein acts like *A* II, but it is obvious from the electrophoretic data presented above that *A* II is not of histone or protamine nature. The individual amino-acids contained in clupein do not act as precipitating agents on the jellies, nor do a number of other amino-acids tested.

From the sperm of salmon an *A* II fraction is obtained in the same way as that described above. It precipitates the jelly of sea urchin eggs. It has a similar ultra-violet absorption spectrum and is easily inactivated by trypsin, as is the sea urchin *A* II.

The methanol extract was evaporated and the residue was extracted with sea water at 85–90° for 3–5 minutes. A faintly yellow solution resulted. This solution contained *A* I. A drop of sperm was introduced between cover-slip and slide and an equal drop of the extract was added. The *p*H of this was adjusted to about that of sea water. The sperm was immobilized. In other experiments, the dried sperm was extracted directly with warm sea water without previous treatment with methanol (Frank's method[5]). The opalescent extract was as active as *A* II, but no *A* I activity could be demonstrated. It seems doubtful whether fraction *A* I takes any part in Psammechinus or Echinocardium sperm. In undiluted suspensions obtained from the testis, the sperm is very active at the boundary of a drop, where oxygen uptake and outward diffusion of carbon dioxide are sufficient. The *A* I fraction seems in our species to be liberated in sufficient quantities only after extraction with methanol. Nevertheless, *A* I plays an important part in the salmon. The immobilization of the sperm in dense suspension is due to *A* I. On dilution, the sperm becomes mobile, but addition of a solution containing *A* I from the sea urchin or from salmon immobilizes the sperm in a reversible manner. It was found for the salmon *A* I that it diffuses through 'Cellophane'. This is probably true also for sea urchin *A* I. Neither the salmon nor the sea urchin *A* I is inactivated by trypsin.

The methanol extract contains still another factor which may be designated as *A* III. It is active on the surface of the egg. Its presence is demonstrated by the following test[4]. Unfertilized eggs deprived of their jelly are placed in a hypertonic solution (2 ml. sea water + 0·6 ml. 2·5 *N* sodium chloride). When the eggs shrink in this solution, the surface acquires numerous small wrinkles. In the course of about an hour the surface becomes smooth (the duration of the wrinkled state is subject to variations according to the material and the conditions). Unfertilized eggs pretreated for 20–30 minutes with sea water containing *A* III shrink with a smooth surface. In eggs transferred from a hypertonic solution containing *A* III a fairly vivid streaming of the cytoplasm occurs. The action of *A* III may be interpreted as a liquefaction of the cortical layer[6]. *A* III of sea urchin sperm dialyses through 'Cellophane'. It is seemingly not attacked by trypsin. *A* III is not identical with *A* I. The latter factor is more strongly adsorbed by aluminium oxide and hydroxide than is the former. The adsorption experiment was carried out with extract from sea urchin as a front analysis following Tiselius[7]. Only the first portion of the fluid pressed through the aluminium oxide filter is devoid of *A* III. The subsequent portion shows *A* III activity, while no portion shows *A* I activity. Displacement and elution experiments also prove that *A* III is more loosely bound to aluminium oxide or hydroxide than is *A* I.

The solution containing *A* I and III acts as an inhibitor to *A* II, while this latter factor does not impede the action of *A* III.

A I is resistant to treatment with normal hydrochloric acid at 100° for at least 30 minutes. *A* III under these conditions is not destroyed, but its activity somewhat diminishes.

A methanol-soluble factor from both sea urchin and salmon sperm has a tendency to hæmolyse red mammalian corpuscles or at least to change the normal biconcave form of the corpuscles into a spherical form with a smooth surface. These changes resemble those occurring in the sea urchin egg under the action of *A* III. In view of this and other facts, the change of the red corpuscles may be ascribed to *A* III.

Besides the agent which changes the form of the corpuscles, the methanol extract seems also to contain a factor which causes agglutination of the corpuscles.

For a more complete review of literature see refs. 4 and 8. Further details of the results will be published elsewhere.

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1 Hartmann, M., and Schartau, O., *Biol. Zentralbl.*, **59**, 511 (1939).
2 Hartmann, M., Schartau, O., and Wallenfels, K., *Biol. Zentralbl.*, **60**, 388 (1940).
3 Flosdorf, E. W., and Mudd, S., *J. Immun.*, **34**, 469 (1938).
4 Runnström, J., Tiselius, A., and Vasseur, E., *Arkiv för Kemi* (Stockholm), **15** A, Nr. 16 (1942).
5 Frank, J. A., *Biol. Bull.*, **76**, 190 (1939).
6 Runnström, J., Monné, L., and Broman, L., *Arkiv för Zoologi* (Stockholm), **35** A, Nr. 4 (1943).
7 Tiselius, A., *Arkiv för Kemi* (Stockholm), B **14**, Nr. 22 (1940). Tiselius, A., and Claesson, S., *Arkiv för Kemi* (Stockholm), B 15, Nr. 18 (1942). Tiselius, A., *Koll. Z.*, **105**, 101 (1943).
8 Hartmann, M., "Die Sexualität" (Leipzig, 1943).

Blind Seed Disease of Rye-Grass

INVESTIGATIONS on blind seed disease of rye-grass have been continued in Northern Ireland since 1940[1]. In agreement with Neill and Hyde[2,3], and Wilson, Noble and Gray[4], sporodochia producing endogenous microspores have been observed on affected seeds and also in culture.

Inoculation experiments were carried out during the summer of 1941, using the same technique as in 1940. Again *Pullularia pullulans* proved to be non-parasitic. Using the blind seed fungus (*Phialea temulenta* Prill. and Delacr.) and employing suspensions of ascospores and macrospores, heavy infections with the disease were obtained at flowering time with one commercial type and two indigenous strains of perennial rye-grass and one commercial type of Italian rye-grass. When inoculations were made after fertilization, the amount of infection rapidly declined. The seed produced was tested for germination and highly significant negative correlations were obtained between percentage infection and percentage germination for each variety used.

In August 1942 the blind seed fungus was isolated from seeds of sheep's fescue (*Festuca ovina*), bent-grass (*Agrostis canina*), fiorin-grass (*Agrostis palustris*), smooth-stalked meadow-grass (*Poa pratensis*), Yorkshire fog (*Holcus lanatus*) and crested dog's-tail (*Cynosurus cristatus*), by plating out infected kernels on a suitable medium after surface sterilization and bisection[2]. Yorkshire fog and crested dog's-tail were only very lightly infected and the percentage of seeds from which the fungus was isolated was very low. Cultures from bent-grass, sheep's fescue, smooth-stalked meadow-grass together with one from rye-grass were used for inoculation experiments in 1943, and successful results were obtained with meadow fescue (*Festuca elatior*), rough-stalked meadow-grass (*Poa trivialis*) and rye-grass.

Investigations on the control of the disease by seed disinfection were carried out during 1940–43. These included laboratory, pot and field tests. Dry and short-wet treatments with seed disinfectants, including organo-mercury compounds, were not altogether satisfactory. Treatment with hot water for fifteen minutes at 50° C. following pre-immersion for four hours in tepid water, or for thirty minutes at 50° C. without pre-immersion, gave full control of the fungus. There was little, if any, reduction in germination following upon this treatment when the drying of the seed was carried out immediately. These results were confirmed in pot and field experiments, where apothecia were collected from all plots except those sown with seed subjected to the hot-water treatment. It was also observed that, after the hot-water treatment, infected seeds decayed readily in the soil whereas in other cases they remained firm and unchanged.

In a field experiment in 1941, where the plots were separated by paths two yards wide, it was found that no treatment reduced the amount of infection present in the seed produced. This was due to the fact that ascospores were carried from plot to plot to bring about primary infection. In order to overcome this difficulty, small plots, well isolated from rye-grass crops, were sown with infected seed subjected to the hot-water treatment, which was shown by laboratory tests to be completely effective in killing the parasite. Similar plots in other districts were sown with untreated seed. Examination of the seed produced showed that the percentage infection in ten of the plots sown with untreated seed varied from 0 to 38 with a mean of 8; in the case of fifteen plots sown with treated seed the corresponding range was from 0 to 55 with a mean of 11 per cent. These results suggest that infection from a source other than the seed sown had occurred, probably through apothecia produced on infected seed from plants in hedgerows, untopped pastures and waste-ground. Such being the case, seed treatment cannot be expected to provide satisfactory control except under conditions of perfect isolation.

Since 1939 a large number of seed samples have been examined and the results indicate clearly that strains of indigenous perennial rye-grass are more susceptible to blind seed disease than commercial types. The amount of infection has varied from year to year and, since these observations were commenced, serious infection has been recorded only in 1939 and 1943. During the years 1940–42 only occasional samples examined showed heavy infection. In 1941 the seed from one field of indigenous rye-grass, sown with disease-free seed in the spring of 1940, showed infection ranging from 31–55 per cent for six samples examined. In the seed from several other crops, produced from the same parent seed, the disease was absent or present only to a very small extent. On investigating the crop rotations it was discovered that in the former case rye-grass had followed a four-year lea, while all the other crops had been sown on land which had been in arable crops for from three to four years. It seems clear that the amount of infection had been influenced by the previous cropping. Much of the seed produced from these crops was sown in the spring of 1942 and about 160 samples from the resultant crops were examined in 1943. The amount of infection varied and in some cases it was so high as 70 per cent, probably as a result of the suitable weather conditions for infection which prevailed during May and June. A significant result which emerged from this examination was that the seed samples from fields sown with the heavily infected seed did not, on the average, show a higher percentage infection than those from fields sown with practically disease-free seed.

Since rye-grass is of primary importance as a forage crop and as the use of the seed is largely limited to the propagation of the species, too much importance could be placed upon reduced germination due to the incidence of blind seed disease. Until evidence has been produced to show that the causal parasite affects the value of the crop in some other way, it must be assumed that the damage is confined to an attack upon the seed. The seed from indigenous strains is certainly more liable to heavy infection than that from commercial types; but if, on the other hand, the crops from indigenous strains are of much greater feeding value, then a certain reduction in the percentage germination of the seed would appear to be of secondary importance. In Northern Ireland there would be very few, if any, seasons when, by proper blending, the seed could not be brought up to a standard of germination suitable for incorporation in mixtures intended for pasture establishment in non-seed-producing areas. The best seed should be reserved for distribution in seed-producing areas. By this means a supply of seed of the valuable indigenous strains already in existence would be made available until such time as leafy strains resistant to blind seed disease can be introduced.

The occurrence of seasons at irregular intervals when

the germination of rye-grass seed is below average is common knowledge, and all available evidence indicates that this reduced germination is due to the incidence of blind seed disease. The disease must, therefore, be regarded as of long standing, attention having been focused on it in recent years due to the susceptibility to attack shown by indigenous strains of rye-grass.

It is not unlikely that the natural susceptibility of such strains to the disease coupled with their shyness in seed production has operated as a primary factor in bringing about their general elimination from commerce. The continuous harvesting of the seed without sufficient reference to the strain of the grass would operate automatically in the same direction, and the forage value of the crop which, after all, is of the greatest importance, may have suffered in consequence.

E. L. CALVERT.
A. E. MUSKETT.

Plant Disease Division,
Ministry of Agriculture,
The Queen's University,
Belfast. Jan. 18.

[1] Muskett, A. E., and Calvert, E. L., NATURE, 146, 200 (1940).
[2] Neill, J. C., and Hyde, E. O. C., *N.Z. J. Sci. and Tech.*, 20, 281A (1939).
[3] Neill, J. C., and Hyde, E. O. C., *N.Z. J. Sci. and Tech.*, 24, 65A (1942).
[4] Wilson, M., Noble, M., and Gray, E. G., NATURE, 146, 492 (1940).

White Plumage of Sea-Birds

IT is often considered that the white plumage of gulls, terns, gannets, etc., in temperate climates is in contradiction to the principle of protective and adaptive coloration, and survives only because these birds are relatively safe from attack and able to protect themselves. Thus Cott[1] remarks that "in any normal surroundings" they are "positively conspicuous" but considers that their strength and pugnacity protect them.

As is now well known, aircraft of Coastal Command on anti-submarine patrol are painted white on their undersides. This treatment was devised by Merton of their Operational Research Section on theoretical grounds, to render them less visible to submarines. Since any natural object is less bright than the sky, it will appear dark when seen from below against the sky, though at long distances the contrast will be slight, due to the great amount of scattered air-light between observer and object. Merton showed that a white object will have a smaller contrast against the sky than a darker one, even at ranges of several miles, and that white paint should therefore decrease the range at which the submarine look-outs spotted the aircraft and gave warning to submerge. Surely the same end may have been achieved, by natural selection, in the white coloration of the undersides of many sea-birds which depend for their food on spotting and catching fish very near the surface. If the bird is white its contrast against the sky will be smaller and the fish will be less likely to see it in time to dive beyond the bird's reach. As the visual acuity of fish is much poorer than that of man the ranges involved are short and the reduction of contrast by scattered light negligible; hence the benefit of white coloration will be greater than in the case of aircraft.

The majority of sea-birds (apart from shore-feeders) which have dark plumage, like cormorants and guillemots, are diving birds which swim at considerable depths; it should therefore matter little to them whether fish dive deeper at their approach—perhaps indeed they see fish from below in silhouette, in which case their own dark coloration would be an advantage.

K. J. W. CRAIK.

Psychological Laboratory,
Cambridge.
Nov. 24.

[1] Cott, H. B., "Adaptive Colouration in Animals" (Methuen 1940).

Analysis of Barley from King Tuthankhamen's Tomb

THROUGH the kindness of Mr. J. Philp, chief botanist of the Ministry of Agriculture, Egypt, we recently obtained a small sample of ancient Egyptian barley from the Museum of Antiquities, Cairo, which came originally from the tomb of Tuthankhamen (*c.* 1350 B.C.). The barley is extensively carbonized, but its structure is sensibly undamaged and the germ, for example, with its scutellum and embryo components, is still intact. It has, however, apparently lost a considerable amount of weight and its density is only about two thirds that of fresh English barley.

No vitamin B_1 could be detected in the grain, even in the dissected scutellum. On the other hand, the contents of riboflavin and nicotinic acid, as determined by microbiological assay, were found to be 0·85 μgm. and 28 μgm./gm. respectively: the corresponding values for fresh barley average 2·5 μgm. and 90 μgm./gm.

The total phosphorus in the barley was found to be 414 mgm. per 100 gm. and the phytate phosphorus 0·4 mgm./100 gm. Average values for fresh barley are 370 and 249 mgm./100 gm. respectively. There has, therefore, been practically complete hydrolysis of the phytic acid originally present in the grain, but no trace of an active phytase can now be found. Likewise the grain gives no reaction for phosphatase.

It is surprising to find that a molecule so complex as riboflavin could survive for such a long period. Part of the explanation is to be found in the very low relative humidity in the tomb, while we have also observed that the barley has increased in acidity, a 1 per cent suspension giving a pH value of 4·1 as against 6·25 for fresh barley. We have no information on how the barley was stored: but it is possible that its preservation was helped by an oxygen-free atmosphere created by its own respiration and the oxygen uptake of other products stored with it.

Although the germ was intact, it was found to contain a number of well-defined crystals, and these are being examined by our colleague, Dr. Hinton, in an attempt to establish their chemical identity. It will also be of interest to know if the crystals are composed of a product with a very small velocity of crystallization.

E. C. BARTON-WRIGHT.
R. G. BOOTH.
W. J. S. PRINGLE.

Cereals Research Station,
Ministry of Food,
St. Albans.
Feb. 10.

BIOCHEMICAL IMPORTANCE OF INDIVIDUAL AMINO-ACIDS

THE biological importance of a protein is dependent on the extent to which it is able to supply the amino-acids which the animal cannot synthesize for itself. Willcock and Hopkins (1906–7) showed that young mice, fed on a diet in which zein was the sole protein, lost weight and died in about 17 days. The addition of tryptophan to the diet enabled the mice to survive for longer periods, although they continued to lose weight. In 1914, Osborne and Mendel repeated the experiments and found that, in growing rats, the addition of tryptophan enabled the animals to maintain their normal weights, and that with the further addition of lysine normal growth was restored. Tryptophan and lysine were therefore regarded as essential amino-acids, the list of which was afterwards extended to include histidine, threonine, valine, phenylalanine, leucine, *iso*leucine and methionine or possibly cysteine. The discovery of threonine by Rose (1931) was the direct outcome of experiments involving the feeding to rats of synthetic mixtures of all the amino-acids known at that time. The rats failed to grow, and Rose concluded that proteins probably contain an unknown amino-acid, which was afterwards isolated and identified as α-amino-β-hydroxy-*n*-butyric acid (threonine).

Essential amino-acids then, in common with vitamins, cannot be synthesized in the mammalian body and have to be supplied in the diet. Unlike vitamins, which are present in small quantities in the tissues, amino-acids, combined in proteins, form a large part of the total mass of the body, and the quantitative requirements of essential amino-acids are therefore considerably greater than those for vitamins. The deleterious effect of a dietary deficiency of a particular amino-acid will be less marked and sudden, therefore, in the adult animal, due to the great store of amino-acids which the body has in its proteins.

Essential amino-acids may have different biological functions. One may be needed only as a building material for the synthesis of protein, in which case a lack of that amino-acid in the diet will result only in an inhibition of protein synthesis, the severity of the symptoms from which will depend on the quantitative requirements of the body relative to its stores of that amino-acid. Another may be indispensable because of its role as a precursor of, for example, a ductless gland secretion, such as adrenaline, which is probably derived from phenylalanine. Cysteine or methionine are the principal sources of sulphur to the animal body, and are probably precursors of glutathione, taurine, insulin, keratin, etc. Valine deficiency in rats produces characteristic nervous symptoms, involving extreme sensitivity to touch and severe lack of co-ordination of movement, suggesting a special role of this amino-acid in the central nervous system. The precise part played by tryptophan is still a matter of conjecture, but from the severe effects which follow its removal from the diet, it seems evident that it has some special function to perform apart from protein synthesis. Its effect on the growth of one of the simpler invertebrates, Obelia, suggest that it may control the speed of metabolism. Histidine is probably the precursor of histamine, ergothionine, carnosine and anserine (found in goose muscle). Lack of lysine produces no specific symptoms apart from cessation of growth, although animals kept on lysine-deficient diets are not static as regards the development of individual tissues and organs. Thus body, tail and leg bones increase in length, and organs such as eyes and kidneys increase in weight, while others, such as muscle, decrease. Although male genital organs are unaffected, the œstrus-cycle may be suspended. Lysine is thus probably required as a purely passive material for the synthesis of protein.

H. A. Harris, A. Neuberger and F. Sanger (*Biochem. J.*, 37, 508; 1943) have recently shown that lysine deficiency in rats produces cessation of growth and hypoproteinæmia. The number of red cells and the amount of hæmoglobin per unit volume of blood are slightly less than in the controls, and this is interpreted as indicating not so much an anæmia proper as a retarded development of the hæmopoietic system. A comparison of the radiographs of the control and lysine-deficient rats showed great differences in the bodily dimensions. Normals are well covered with subcutaneous fat and muscle as compared to the lysine deficients, in which the degree of calcification in all bones is generally reduced. The epiphyseal cartilage of the long bones is barely visible and histological examination reveals considerable reduction in the number of chondroblasts in the first zone of proliferating cartilage. In the zone of calcified cartilage, the trabeculæ of calcified matrix are heavier in the deficient animals than in the controls. Mitotic figures in the testes are reduced as compared with controls.

The changes observed are assumed to be due to a general inhibition of protein formation, leading to reduced growth of some organs which develop at the expense of others not unlike the picture produced by ordinary starvation. Protein is transferred according to a fixed system of priorities, and the sum total of these changes is constant body weight, although the animal is no longer the same animal. It is noteworthy that lack of one essential building unit in the diet produces essentially the same symptoms as underfeeding, and if only one essential amino-acid is missing from a protein then that protein is rendered unsuitable as the sole source of nitrogen in the diet of the young or adult animal. Cadet de Vaux in Paris during the French Revolution tried to persuade the poor that gelatin soup was a satisfactory and nutritious diet. The poor refused, and their attitude has since been shown to have been amply justified, as gelatin contains no valine, *iso*leucine or tryptophan.

T. F. DIXON.

BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION

THE twenty-second annual report of the British Electrical and Allied Industries Research Association (E.R.A./T341) summarizes the work which has been carried out during the year ended September 30, 1943, and again lists, by titles, the various research reports which have been issued during the year. The work is reviewed under the same eighteen major classifications as last year, among which dielectrics, cables and overhead lines, electric control apparatus, and magnetic materials figure largely.

The report shows that the work of the Association has been carried on during the year by 108 active technical sections, sub-committees and panels formed from workers in industry and academic institutions.

Seventy-five technical reports on various subjects have been issued during the year, as compared with fifty-seven in the previous year.

The Information Bureau has accorded significant help, not only to members but also to Government and Service departments. Many inquiries for translations have been received from members, and these have met with prompt response. The rate of preparation of translations now averages about one a week, and in future a six-monthly list will be distributed to members showing the translations completed during the period. The list will also include bibliographies which have been prepared from time to time in response to particular requests. A complete revision of the annotated list of reports is nearly completed and progress has been made on the complete analytical index to E.R.A. reports. The section on overhead lines will be distributed shortly, and as soon as possible a consolidated index to the complete sections on materials covering all reports to date will be issued. A corresponding issue for technical subjects will follow later.

During the year there has been a further increase in the amount of direct assistance to the war effort given by the Association. The British Coal Utilization Research Association having secured a site near Leatherhead railway station offered part of it to others, as a result of which the E.R.A. decided to negotiate the purchase of an adjacent site and co-operate with the other interested associations in order to secure joint action in matters of common interest and the sharing of common facilities and amenities. It is likely that this will lead to an important group of industrial research laboratories being developed in the area.

Regarding insulating materials, during the year the E.R.A. alone has issued reports representing an expenditure of upwards of £10,000 on the properties of insulating materials. The importance of skilled methods of manufacture, testing and selection has been emphasized under war conditions, and the value of statistical methods of assessment of quality is receiving increasing attention. Now that industry has provided adequate testing facilities for making performance tests on circuit breakers at full power, the study of arcing phenomena and parallel commercial developments are now leading to general development of air-blast circuit breakers for service for which this type is appropriate. A successful application to the High Court by the E.R.A. for extension of the life of its principal patent in this field presented novel features. The special committee established to apply scientific methods to the study of electricity supply technology shows promise of increasing importance, and the willingness of supply engineers to attend committee meetings dealing with important aspects of this matter provides adequate proof of the interest these subjects have aroused.

For many years the Association has sought to secure that attention should be given in Great Britain to the improvement of magnetic sheet steel commensurate with its importance in the design of electrical plant, and during the year all the interests have been brought together and the problem is receiving detailed consideration. The study of surge phenomena constitutes an important section of E.R.A. work. It is interesting to note the work on development of methods of assessing the liabilities of a given overhead line in relation to lightning based on statistical study, and the application of the theory of development of the lightning stroke. Both the requirements of war-time and prospective post-war needs serve to emphasize the importance of the applications of electricity to food production. Having made timely provision for the study of rural electrification problems and all that arises therefrom, the Association continues to conduct and co-ordinate much useful work in this important field.

ENEMY AIRBORNE RADIO EQUIPMENT

At a meeting of the Wireless Section of the Institution of Electrical Engineers held on November 24, C. P. Edwards, of the Royal Aircraft Establishment, South Farnborough, presented a paper entitled "Enemy Airborne Radio Equipment". This paper, to be published in due course in the *Journal* of the Institution, contains descriptions, with more than twenty photographs and diagrams, of the most widely used radio-communication installations and aids to navigation found in German military aircraft, with a brief mention also of Italian and Japanese practice. At the meeting, the author demonstrated a complete reassembly of the general-purpose communication installation used in all German bombers, twin-engined fighters and certain flying boats, this whole equipment weighing approximately 360 lb. This installation includes separate transmitter and receiver units for each of two wave-bands, the medium-frequency covering the range 300–600 kc./sec. and the high-frequency units 3·0–6·0 Mc./sec. The equipment is noteworthy for the fact that the number of types of valves required has been reduced to the minimum: in each of the two transmitters, three valves all of one type are used; while the twenty-five valves used in the two receivers and also in the intercommunication amplifier and miscellaneous valve circuits are all of one type.

An advanced type of rotating-loop direction-finder is incorporated in the installation, with provision for aural reception and visual indication of the direction of the incoming signals. The loop itself is of considerable interest, being of a radically new shape with an iron-powder core, and mounted inside the fuselage under a shallow, protecting stream-lined blister. The loop is turned by the aid of a rotary flexible shaft, and the remote scale is mounted concentric with a repeater compass scale, so that radio bearings may be read off directly, either relative to the aircraft axis for homing purposes, or relative to true or magnetic north and corrected for quadrantal error. An additional receiver with visual indicator is provided for use with the Lorenz system of beam approach towards beacons emitting on frequencies in the region of 30 Mc./sec.

The paper next describes the somewhat simpler radio-telephone installation used in the single-seat fighter, giving one spot frequency in the band 2·5–3·75 Mc./sec. The operational frequency requires to be set up before the aircraft leaves the ground, since no remote tuning control is provided. Production of this equipment probably started in 1935, and it is still in general use. Certain aircraft of the single-engine dive-bomber type are fitted with a remote-controlled medium-frequency homing device in addition to the communication equipment. This comprises a fixed iron-cored receiving loop connected to a receiver covering one frequency band of 250–400 kc./sec.

Other German equipment described and illustrated

in the paper comprises transmitter-receiver units for the frequency range 38·5–42·3 Mc./sec. for air-to-air and short-range air-to-ground telephonic communication, and somewhat similar units as fitted in Army co-operation aircraft and covering the range 42·1–47·9 Mc./sec., with additional facilities for telegraphic signalling.

A brief description is also given of the installation, now known to be obsolete, used in an Italian bomber which was shot down on the east coast of England in 1940. As examples of Japanese practice, brief accounts are given of the equipments used in the "Zero" fighters and certain types of Navy bomber.

The paper concludes with a short commentary on the design and lay-out of the various installations examined, and of the materials and components used. Much of this development and production work is undoubtedly very advanced, and the information which the author has collected and reproduced should prove of value to those responsible for the design and manufacture of radio equipment for aircraft.

RESEARCH AND THE IRON AND STEEL INDUSTRY

SINCE the Heterogeneity of Steel Ingots Research Committee started its work in 1924, this aspect of the interests of the Iron and Steel Institute and the British Iron and Steel Federation has progressed continuously. At present, there are in being some twenty-three such research committees of one kind and another, of which the main, in addition to the Ingots Committee itself, are those concerned with the Alloy Steels (1934), Corrosion (1928), and Steel Castings (1934). A review of their work over a period of twenty years was initially prepared by the late Dr. W. H. Hatfield, and has now been issued*. Hatfield's tragic death has removed the one around whom, more perhaps than any other, these committees and their work have revolved.

The data which have been collected during this time have resulted from the joint efforts of the industry itself, the university, governmental and similar institutions, and affords an outstanding example of the fruitfulness of such an association. The present writer, in the past, has not been uncritical, but this publication provides undoubted evidence of the existence of a far more healthy spirit than obtained until comparatively recently, and, further, one which may be believed to be permanent. The ready willingness of so many industrial research establishments to assist in, and to further, the work being done in academic laboratories, is also deserving of special mention. In any future developments envisaged for the encouragement of research into the particular problems of the iron and steel industry, it is a matter of first-rate importance that this collaboration should be maintained, and that no aspect of research activity should be neglected.

The essential purpose of the present report, to give a fairly detailed summary of the work already accomplished by the various committees, is very well done, and a most substantial addition to our knowledge of the nature of steels, their manufacture and properties, has resulted. How widespread have been the interests of these bodies, especially in more recent years, may be illustrated from some of the researches of the Ingots Committee or its offshoots. These have ranged from studies of slag equilibria to the effect of casting speeds; from the use of radioactive materials in the examination of inclusions, to rimming steels. All these are clearly of fundamental importance from the point of view of the technology of the industry, but many are making a by no means unimportant contribution to scientific knowledge in general. In this connexion, it may be sufficient to cite the work on the accurate measurement of the very high temperatures employed in steel-making.

An interesting aspect of the report is the survey of further work already commenced or contemplated. As, from some points of view, the whole scheme has become more and more interesting as time has gone on, these researches will be looked forward to with keen anticipation. F. C. THOMPSON.

* Iron and Steel Institute. Special Report No. 29: Review of the Work of the Joint Research Committees 1924–1943 of the Iron and Steel Institute and the British Iron and Steel Federation. Pp. viii +176.

TREATMENT OF SHOCK BY HEAT

THE principle of treating traumatic shock by the application of heat has become so well established and has been so much emphasized in first-aid services during the War that the investigations done by A. W. Kay, of the University of Glasgow (*Brit. Med. J.*, 40, Jan. 8), will interest many besides the medical profession.

Mr. Kay has studied the effects of heat on healthy young adults, and he points out that the results cannot be properly applied to patients suffering from traumatic shock; but he thinks that they do suggest that we should study more carefully the effects of heat on shocked people. While the condition known as shock is not yet fully understood, it has been believed, as Mr. Kay points out, that heat helps recovery from shock mainly by relieving the vaso-constriction of the cutaneous blood-vessels and so helping the venous return of the blood. It has only recently been suggested that this vaso-constriction may be a compensatory mechanism and that heat may therefore be harmful.

Mr. Kay's subjects were heated in a hot-air cradle to 38–40° C. for one hour, ten of them receiving normal saline intravenously and five of them receiving plasma intravenously throughout this period. Three experiments had to be abandoned because of the severe symptoms (headache, nausea, exhaustion) and anxiety produced. Nine cases showed evidence of dehydration (dry tongue, weakness and thirst) and all cases showed general perspiration and increased pulse-rate. Nausea occurred in six cases.

The essential factor suggested as the cause of these troubles is general peripheral dilatation, which caused a lowering of the arterial blood pressure and a rise of venous pressure. Since most accepted forms of treatment of shock aim at raising the blood pressure, and since the subjects of these experiments showed a constant and progressive lowering of the blood pressure, the *prolonged* use of heat for the treatment of traumatic shock would appear, in Mr. Hay's opinion, to be contraindicated.

An annotation in the same issue of the *British Medical Journal* gives other references to work on this subject done on man and animals. Further work is clearly required, and it is suggested that intracardiac catheterization might open up a new era in the study of cardiodynamics.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, March 4

BRITISH ASSOCIATION OF CHEMISTS (LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. T. J. Drakeley: "Training for the Chemical Industries".

GEOLOGISTS' ASSOCIATION (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. H. H. Read, F.R.S.: "Meditations on Granite", Part 2 (Presidential Address).

Monday, March 6

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir William T. Halcrow: "Natural Resources of Great Britain", 3: "Hydro-Electric Power" (Cantor Lectures, 3).

SOCIETY OF CHEMICAL INDUSTRY (LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. C. M. Whittaker: "The Applications of Dyestuffs to the Newer Synthetic Fibres".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Mr. K. de B. Codrington: "Valleys of the Hindu Kush".

Tuesday, March 7

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. Tadeusz Sulimirski: "Some Remarks concerning the Problem of the Origin of the Slavs".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at the University, Manchester), at 5 p.m.—Mr. P. D. Mehta: "Asoka, the Philosopher Emperor".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. A. R. Todd, F.R.S.: "The Mode of Action of some Vitamins", 1.*

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. H. D. Murray and Dr. G. W. W. Stevens: "Theory and Practice of Reflex Copying".

Wednesday, March 8

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. Paley Yorke: "Education To-day and To-morrow", 5: "Technical Education".

PHYSICAL SOCIETY (COLOUR GROUP) (in the Physics Department of the Imperial College, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Fourth Annual General Meeting; at 2.45 p.m.—Dr. J. H. Saxby: "The Sub-Committee on Colour Deficiency in Industry; a Progress Report".

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. E. C. Neate and Mr. W. F. Bowling: "Reinforced Concrete Transmission Line Supports".

Thursday, March 9

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Sir Jack Drummond: "Food Fads and Food Fallacies".*

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. Hamlyn Drake: "The Influence of Maintenance Requirements on the Design of Electrical Installation Equipment".

Friday, March 10

ROYAL SOCIETY OF ARTS (INDIA AND BURMA SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. Maurice S. Collis: "The Achievement of Burma".

PHILOLOGICAL SOCIETY (at the School of Oriental and African Studies, University of London, Malet Street, London, W.C.1), at 4.15 p.m.—Mr. A. S. C. Ross: "A Finnougrian-Indoeuropean Loan-word Problem".

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Discussion on "Solar Phenomena" (to be opened by Mr. H. W. Newton, Mr. C. W. Allen, Mr. M. A. Ellison and Mr. H. A. Brück).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. D. M. S. Watson, F.R.S.: "Habit and Evolution".*

UNIVERSITY OF DURHAM PHILOSOPHICAL SOCIETY (in the Physics Lecture Theatre, King's College, Newcastle-upon-Tyne), at 5.15 p.m.—Dr. M. P. Applebey: "The Future of Research".*

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ELECTROTECHNOLOGY in Santa Maria, Chile—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.763.XA) (March 8).

LECTURER (man or woman) IN BOTANY, a DEMONSTRATOR (man or woman) in BOTANY, and a MUSEUM ASSISTANT (man or woman)—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (March 8).

ASSISTANT TEACHER (man or woman, temporary) OF MATHEMATICS at the York School of Commerce—The Secretary for Education, Education Offices, York (March 11).

ASSISTANT MASTER (graduate) TO TEACH MATHEMATICS principally, at the Sheffield Junior Technical School for Boys—The Director of Education, Education Office, Leopold Street, Sheffield 1 (March 11).

SENIOR MATHEMATICS MISTRESS at the Middlesbrough High School for Girls—The Director of Education, Education Offices, Middlesbrough (March 11).

LECTURER IN MATHEMATICS AND MECHANICAL ENGINEERING—The Principal, Derby Technical College, Normanton Road, Derby (March 13).

DEPUTY WATER ENGINEER AND MANAGER on the established staff of a large County Borough in Surrey—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E 887.XA) (March 15).

CHIEF ENGINEER, Port of Basrah, by the Government of Iraq—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.756.AX) (March 17).

ASSISTANT TO THE REGISTRAR AND SECRETARY—The Registrar, Royal Institute of Chemistry, 30 Russell Square, London, W.C.1 (March 18).

PSYCHIATRIC SOCIAL WORKER (Woman) for Child Guidance Clinic at Harrow—Mr. C. W. Radcliffe, "R.2", Clerk to the Middlesex County Council, Middlesex Guildhall, Westminster, London, S.W. (March 18).

ASSISTANT TECHNICAL OFFICER, ASSISTANT DRAINAGE OFFICERS (2), and an ASSISTANT HORTICULTURAL OFFICER, to the Essex War Agricultural Executive Committee—The Executive Officer, Essex Institute of Agriculture, Writtle, Chelmsford (March 20).

LECTURER IN MECHANICAL ENGINEERING—The Clerk to the Governors, Heanor Mining and Technical School, 30 Mansfield Road, Heanor, Derbyshire (March 22).

METALLURGIST (well-qualified) to take charge of Research and General Laboratories, Heat Treatment, etc., in Sheffield Steel Works—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F 2048.XA) (March 31).

PROFESSORSHIP OF CHEMICAL TECHNOLOGY—The Vice-Chancellor, University of Madras, Triplicane P.O., Madras India (March 31, by cable; at the same time advise the Office of the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

DRUMMOND PROFESSORSHIP OF POLITICAL ECONOMY—The Registrar, University Registry, Oxford (May 13).

HEADMASTER OF THE PARK HIGH SCHOOL FOR BOYS, and an ASSISTANT MASTER OR MISTRESS (temporary) to teach SCIENCE and MATHEMATICS—The Director of Education, Hamilton Square, Birkenhead.

ASSISTANT TIME STUDY ENGINEER—The Ministry of Labour and National Service, Appointments Office, 2 Calthorpe Road, Five Ways, Birmingham (quoting Reference No. 691).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

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SCIENTIFIC AND INDUSTRIAL RESEARCH IN GREAT BRITAIN

THE uniformity with which recent reports on scientific and industrial research have insisted that provision for scientific research in Britain was dangerously small before the outbreak of the present War has been taken in some quarters as a disparagement of British achievements. Only the most desultory reading of the reports in question could afford any support for that contention; on the contrary, there is general agreement as to the ability of scientific men in Great Britain and the merits of their achievement, as emphatically as there is agreement that the *per capita* appropriation in Great Britain, both for industrial and for public research, has been far below that in the United States of America and the U.S.S.R. It was a disappointing feature of the report of the Larke Committee on Industry and Research that it provided such meagre information under this head, but there can be no doubt that, had such information been incorporated in that report, it would have corroborated the evidence submitted by the Parliamentary and Scientific Committee.

In a particular field this is well illustrated by the report on methods of building in the United States recently issued by the Ministry of Works. This report of a mission appointed by the Minister of Works in July 1943 shows that the building industry in the United States is considerably ahead of that in Great Britain, not so much in the quality or organization of its research as in the scale on which it is prosecuted, the use made of scientific personnel in the industry and the effectiveness with which the results of research are disseminated. There is no doubt as to the appreciation in the United States of the results of British research and of some features of its organization, such as the Building Research Station. None the less, the main burden of this report is similar to that of all the more important recent general reports: more generous endowment and vigorous prosecution of research, the wider employment of scientific personnel at all stages in industry, and more effective means to secure that the results of research are made known in ways that facilitate their utilization in industry. A further special illustration is to be found in Dr. F. King's recent paper on "Petroleum Refining—A Chemical Industry", read on February 4 before the Society of Chemical Industry, when he powerfully urged the importance of expanding the petroleum refining industry in Great Britain by an adequate research and development policy, so as to provide the basic raw materials for a new chemical industry in the manufacture of solvents, plastics and fibres.

This neglect of new discovery was one of the main reasons for the relative decline in British technical efficiency in the inter-war period, and there is little, if any, dissent from the view that it is essential to remedy this position so that the country may be able to hold its own after the War in the general technical progress. There is now general agree-

ment as to the necessity for a marked expansion in the scope of technical and natural scientific research at the universities and other public institutions, as well as in the facilities for training scientific personnel for such work and for industrial research, and probably also that such expansion should be achieved by a suitable increase of the Parliamentary Votes for that purpose; but there is as yet some uncertainty as to how best research should be stimulated in industry itself.

That is one reason behind the controversy at present proceeding as to the suitability of the patent law system of Great Britain under present conditions and the question of compulsory licensing. The question was raised broadly by Dr. P. Dunsheath in his Atkinson Memorial Lecture and, apart from the suggestion that the present system does not really encourage research and development, the discussion has been linked up, on one hand with the wider question of the control of industry by the State, and on the other with the question of the manner in which the State should encourage research by the remission of taxation. The way in which this question is related to that of obsolescence was well put in an article in *The Round Table*, and superficial discussion may easily tend to blame the patent law system or industry itself for shortcomings which are due primarily to an archaic taxation system, out of harmony with the facts and requirements of modern life. The question whether the State should support, without further regulation, research carried on by private firms, either directly by subsidies or tax remission or indirectly by placing at the disposal of industry the facilities of, or results obtained by, public research institutions, has been examined by Dr. T. Balogh in an article in the *Bulletin of the Institute of Statistics, Oxford*. This illustrates the theoretical character of some of the discussions of this subject from the economic point of view. It may be generally conceded that the State's duty in the encouragement of research and development is primarily to foster self-help, under fair conditions, and not in the main to do the job itself; to favour enterprise of the right kind; and to lend public aid where private effort is insufficient. That the imperative task of research is not to maintain particular industries in a particular state of employment or profits, but to increase the national income, even at the cost of very radical adjustments in the structure of industry and employment, and in the use which is made of the nation's total resources, is much more likely to be challenged from the scientific and technical side of industry.

Dr. Balogh follows Dr. C. G. Paterson in arguing that modern development has changed the whole technical and economic background of the patent law system of Great Britain, and that this has not been explicitly recognized either by a reorganization of scientific research or by patent law. He concludes tentatively against subsidies to private investment in plant of existing types without adequate safeguards. While research into new methods or products may be stimulated in this way, as the new and more efficient methods resulting lead to a potential increase in the national real income and in the international competitive capacity of the country, the danger remains that the effectiveness of the new discovery will be either sterilized or used for the purpose of undue monopoly gains. Measures must, he urges, be taken to safeguard the interests of the community and against retardation of progress.

Dr. Balogh has thus really established the case for reform of the principles of inland revenue, but he goes on to expound the view that, as matters stand in Britain, the State must assume the main burden of increased research, and in the main the expansion of research should be undertaken by the universities or other public institutions. He appears to have in mind particularly the establishment of technical institutions on the lines of the Massachusetts Institute of Technology or of the Continental high schools; but since he suggests that the results of such research should be available on a licence basis to industry, presumably he does not favour a policy of full publication. Stimulus to public and private research in conditions which exclude a misdirection and misuse of the results should, in Dr. Balogh's opinion, be one of the main tasks of reconstruction, but his suggestions are likely to bring him under heavy fire from both the industrial and the scientific sides if they are seriously pressed.

The report on scientific industrial research which has been issued by the London Chamber of Commerce* may well be open to a similar type of criticism, at least as regards its chief new proposal for a central research board, both on the grounds of the practicability of finding the type of personnel necessary, and on the desirability or feasibility of the kind of direct control suggested. Much of the report, it is true, is not new. Reiterating that while the inventive genius and scientific knowledge of Great Britain are second to none, financial policy has put us behind others in the adequate provision of equipment for research, facilities for scientific and technical instruction, and such rewards to successful men of science as would ensure a sufficient supply of men of the first quality, the London Chamber of Commerce concludes that there are three essentials to stimulate research into full and fruitful activity.

Of these three essentials, two are in line with the recommendations of earlier reports, namely, a far greater stream of money flowing into research, and a larger, better trained and better paid personnel. The third, and foremost, is new, namely, centralized and planned direction through a central research board. This proposal has something in common with Lord Samuel's subsequent suggestion at the annual luncheon of the Parliamentary and Scientific Committee that the Lord President of the Council should exercise the functions of Minister of Science in the Cabinet.

Lord Samuel's suggestion is admittedly vague and might not in fact amount to much more than Dr. Dunsheath's proposal for a central co-ordinating secretariat and information service. The London

* Report of the London Chamber of Commerce on Scientific Industrial Research. Pp. 16. (London: 69 Cannon Street, 1944.)

Chamber of Commerce bases its proposal on the view that the support which has been forthcoming both from industry and from the Government for the fundamental type of research carried out by the research associations in Great Britain is insufficient to ensure either in quality or quantity the necessary measure of success. An attempt is made in the report to distinguish between 'fundamental' research and 'pure' research, aimed at the increase of natural knowledge for the sake of increasing knowledge and not for any particular industrial objective. The latter type of research, which in practice is hard to differentiate from long-range research on major technical problems, is regarded as an enterprise which should be financed by the nation, and should be carried on in the universities, though the desirability of close relations between industry and the universities in fundamental research, whether prosecuted in industry or at the universities, is recognized and welcomed.

The main purpose of the London Chamber of Commerce in urging the creation of a central research board to act as a co-ordinating and directing body for all research organizations and to form a link between the Government and the research activities of the country at large is to strengthen the present cohesion of our structure of research. The Advisory Council of the Department of Scientific and Industrial Research is not constituted, nor would its present terms of reference enable it to act, in the way and for the purposes now envisaged. A central research board, for example, should have as a primary function the encouragement of private firms to make available to industry at large, through the board, those discoveries which they did not feel it necessary to retain for their exclusive use. The board should accordingly be empowered to make grants, free of income tax, to private firms for such discoveries as are surrendered to the board, and these payments would be designed to encourage firms to complete lines of investigation which they might otherwise abandon as too remote from the problems of their own industries.

A second function of the proposed central research board would be to ensure that adequate facilities are available in every research association for private work, under conditions which would create confidence, on behalf of small firms. It is also proposed that the board should have the right to intervene and require research associations, in consideration of the public funds placed at their disposal, to undertake fundamental research in directions which it judges to be in the national interest, and to require greater activity on the part of those research associations which, in the opinion of the board, are proving unequal to their responsibilities. It should be the further duty of the board to consider the effect upon trade and industry as a whole of discoveries of a fundamental nature, and to direct the use of those discoveries so that they may be of the maximum advantage to the nation.

The duties of the board would not end here. With regard to the fundamental research carried on in the universities, the board would have the function of ensuring that the results of such research would be applied in the shortest possible time. Scientific men in particular may well begin to wonder what manner of men they may be who will constitute the board, and they will be glad to learn that a highly qualified secretariat is recommended to assist in handling the complex problems involved. Again, it is suggested that the Board of Trade or the Department of Overseas Trade should place before the central research board any facts bearing on the loss of markets by British products, at home or abroad, due to poor quality or high price, and the board should take up the matter with the research associations and with individual firms.

Within its charter a central research board should have the same freedom of action as the British Broadcasting Corporation, under the ægis of, and presumably responsible to, the Lord President of the Council. Five industrialists, with practical experience, four men of science, and three representatives of labour, with a whole-time highly salaried chairman, and the full-time, expert secretariat already mentioned, are suggested as constituting such a board. Alternatively, the Council of the Department of Scientific and Industrial Research might be reconstituted on similar lines and its terms of reference widened to permit it to discharge the functions proposed. The present functions of the Advisory Council for Scientific and Industrial Research might then be discharged by a committee of the board. Finally, the question is raised for consideration whether a central research board should delegate its functions concerned with the universities to the University Grants Committee, or to a separate body concerned with research only, leaving the University Grants Committee to continue to function as at present with regard to all funds not specifically earmarked for research.

With regard to finance, the report considers that the universities should maintain a far larger staff than at present of graduates and of skilled laboratory technicians, and recommends a substantial increase in the number of research fellowships at the universities. The whole of the present annual Treasury grant to the universities would be quite inadequate to enable them to carry on the research which the London Chamber of Commerce regards as essential; indeed it strongly supports the Parliamentary and Scientific Committee in its recommendation that a sum of £10,000,000 should be spent over the first five post-war years in equipping and enlarging the university laboratories, apart from carrying out the expansion of the technical and art colleges on a programme estimated before the War to cost £12,000,000. The report urges, however, that all applications for research grants should come to the proposed central research board and be made by it to the Government, and that similarly all grants made by the Government should pass through its hands.

With regard to the research associations, the report advocates a compulsory levy, where necessary, on each industry for which a research association is thought appropriate. Again, the report is in agreement with the view of the Federation of British

Industries that all expenditure on research and development should be chargeable against revenue, either immediately or over the commercial life of any asset created. It also urges that the cost of pilot plant, as well as of laboratory buildings and equipment, should be chargeable against revenue.

The London Chamber of Commerce is impressed with the need for attracting to a scientific career a larger percentage than at present of men with first-class brains, and urges the up-grading of salaries offered to scientific men in industry, the research associations and the universities. Reference is also made to the importance of technical education and of much more generous endowment of the technical colleges; while finally, the importance of publicity is stressed. Individual undertakings must be made more research conscious, including employers, shareholders and workers alike. The report expresses the belief that there are resources of inventiveness and ingenuity among the people of Great Britain generally which skilful propaganda could assist in tapping.

In the main, the London Chamber of Commerce has merely restated the arguments for the expansion of our research effort on lines urged by the Federation of British Industries, the Parliamentary and Scientific Committee, and other bodies and individuals, with the specific exception of its proposal for a central research board. On this proposal two main comments may be made: first, the organization indicated may prove too rigid and demand too much of the individuals constituting the board, which scarcely seems to fit the machinery of government; and secondly, there is no apparent provision for seeing that research is prosecuted in the biological and social sciences in comparison with the physical sciences to the extent required to maintain a better balance in the advancing front of science. That there is need of some further measure of co-ordination of our research effort is scarcely questioned; but the manner in which that can best be planned or controlled without detriment to the internal discipline or freedom of science is a matter for serious discussion.

Here the report does well to raise the question of the adequacy of the University Grants Committee in regard to research purposes, as was done in the report of the Parliamentary and Scientific Committee. The question is also discussed in a recent memorandum on "The Development of Science" issued by the Association of Scientific Workers, which suggests that to assure adequate financial resources for fundamental scientific research and the wise use of those increased resources, a university council, reporting, for example, to the Lord President of the Council, like the Scientific Advisory Committee, should be formed to extend the functions of the University Grants Committee. It should be competent to discuss in detail all questions of university policy, and, without impairing the independence of the individual universities, it would provide a democratic machinery by which the universities as a whole could take the guidance of their future into their own hands, and the Association suggests that a body of the type indicated in the memorandum should achieve a greatly increased measure of self-government of university science by university men of science.

By and large, the stimulation and endowment of fundamental research on an adequate scale is the first and main problem. Opinion may well be reserved as to how far, or how soon, the creation of a university council of the type suggested is likely to proceed without some external stimulus or some far-reaching university reforms; and if university co-operation has not been particularly marked in the past, the capacity of scientific workers to co-operate even within a limited field of science has not been so successful that the prospect of increased self-government will make any pronounced appeal to them or to the community. The first step may well have to be taken by the Government, following the lead given by some such body as the Parliamentary and Scientific Committee. The adequate endowment and prosecution of industrial research should follow from such steps, once fundamental research has been adequately planned and endowed, and given right relations between the State and industry. The discussions which are already proceeding as to the mechanism of State control, the relations between enterprise and planning, between taxation policy and the encouragement of development and research, and between patent law and industrial research are all to be welcomed as contributing to this end. If such discussions can be kept clear of faction or prejudice, and pressed home to lay bare the fundamental issues, they can do much to indicate the right lines on which the organization of research should proceed in Great Britain. They will suggest conditions likely to stimulate creative thought and invention, and also ensure, not merely that the maximum social use is made of advancing scientific knowledge, but also that adequate effort is concentrated in those fields where social needs, instead of financial or other sectional interests, show it is likely to yield the maximum advantage to the community.

WORK OF IMPERIAL CHEMICAL INDUSTRIES, LTD.

THE record of British industrial achievement during the War remains to be written. A veil of secrecy conceals most of it, and it is only here and there and at rare intervals that a small part of the veil is lifted. Such an occasion was Lord McGowan's speech at the Glasgow Chamber of Commerce recently, when, for the first time during the War, he recorded some of the work of Imperial Chemical Industries, Ltd., emphasizing the fact that it was only a small part of the company's activities of which he could speak. The system of private enterprise on which he said Britain's national greatness had so largely been built had been criticized and misrepresented, and it was the duty of British industry to answer vague innuendo with definite fact and record of real achievement. Especially was it a duty owed to the workers and management class who, so far as

his own companies were concerned, had worked faithfully through more than four years of strain and stress, to deliver the goods both to the fighters in the field and to the people at home.

Though designedly limited in scope, the record was impressive, an outstanding feature being the company's pioneer work in the production of oil from coal, a triumph of courage, foresight, research and engineering skill, none of which, said Lord McGowan, would have been forthcoming in adequate degree unless private enterprise had been free to run the risks involved. No State department could have taken such a decision, involving expenditure of millions sterling; and if it had, Parliament would have vetoed the project. As a matter of fact, the decision to erect a plant at a cost of £3,000,000 was carried in the face of strong opposition in Parliament and in the Press. Lord McGowan said:

"I.C.I. were then accused of gambling with shareholders' money and wasting money and energy by making something which could be brought from overseas much more cheaply. What has happened? Before the War that plant gave much new employment at a time when unemployment was rife. It used British coal to make motor spirit instead of this being imported. Its operation afforded technical experience which was very valuable when applied to other products. From the national aspect it was vital."

All this and much else has been more than confirmed during the War. I.C.I. and companies like it have, moreover, formed the only source from which men with experience of large-scale operations could be drawn as key men to operate the vast ministries established for war purposes. In numerous other fields besides the manufacture of oil from coal, I.C.I. has done invaluable work, most of which is based mainly on peace-time research carried out by the company.

Lord McGowan said that he had been astonished by the amount of research and invention since 1939, but most of the results must remain secret for obvious reasons. There is at all events conclusive evidence that the British race has not lost its spirit of inventiveness, and all enemy devices have been more than matched on sea or land or in the air. His company had many inventions which would prove invaluable in peace as in war, such, for example, as synthetic fibres and new kinds of plastics, to say nothing of the many fruits of agricultural research. They were already planning a vast post-war programme which would, among other things, contribute substantially to the provision of full employment envisaged by the Government, and involve an expenditure of many millions of pounds over the next five years for plant replacement, extensions and new factories, including many required for new products. Lord McGowan emphasized that private enterprise is quite capable of showing that spirit of adventure and courage on which the British Empire has been built. His own company, he said, is not peculiar in this: throughout the whole realm of British industry the same spirit reigns, and only asks for freedom and scope to exercise itself.

The student of political and social science should have much on which to ponder here, though it is difficult in such a case to disentangle political bias from scientific objectivity. The address has been criticized as a record that does not necessarily support the doctrine of private enterprise and as not presenting a correct picture of the financial support given, and risks incurred, by the State, for example, in the oil-from-coal enterprise. As a scientific journal we cannot take sides on the political issue; nevertheless, the extent to which scientific research on a large scale has justified itself in this particular example of private enterprise is very impressive. Further, it will be agreed that there appears to be in British industry abundant evidence that the love of adventure and enterprise for its own sake is often as powerful a motive as profit-gaining. It is sometimes complained that we can have no science of society or of politics in the strict sense because we cannot have the same exactness of controlled experiment as in chemistry and physics. One is a little weary of this very unhelpful comparison. At all events the student of political science, if we admit the validity of such, can approach these problems in a scientific spirit, collect such experimental data as are available—frequently more abundant than is commonly supposed—and weigh and evaluate motives and causes with an open mind unclouded by political prejudice.

APPLIED CHEMISTRY

Thorpe's Dictionary of Applied Chemistry
By the late Prof. Jocelyn Field Thorpe and Dr. M. A. Whiteley. Fourth edition, revised and enlarged.
Vol. 5: Feh–Glass. Pp. xxiv+610. 70*s.* net.
An Abridged Index to Volumes 1–5 of the New edition of Thorpe's Dictionary of Applied Chemistry. Pp. 20. 3*s.* net.
Vol. 6: Glau.–Inv.; with an Index to Vols. 1–6, by Dr. J. N. Goldsmith. Pp. xii+611. 80*s.* net.
(London, New York and Toronto: Longmans, Green and Co., Ltd., 1941, 1943.)

THE troubles of producing such a work as this are manifold even in peace-time. When to war conditions we have to add the death of one of the editors, Sir Jocelyn Thorpe, it is really surprising to see that the standard of contributions in these volumes reaches such a high level. Dr. M. A. Whiteley in a foreword refers to the abridged index to Volumes 1–5 published at the same time as Volume 5, and indicates by the phrase "had the Dictionary been published as a complete work" that perhaps no more volumes might appear during the War. Since then, an editorial board has been formed comprising Prof. I. M. Heilbron, Dr. H. J. Emeléus, Prof. H. W. Melville and Prof. A. R. Todd. Dr. Whiteley continues as editor and Dr. A. J. E. Welch as assistant editor. It is hoped to complete the current edition with eight further volumes, published at yearly intervals, and Volume 6 is the first of the new series under the editorial board.

It might be thought that the board of editors are better constituted to produce a dictionary of pure chemistry than one dealing with the applied side. This idea is rather emphasized by the articles on heterogeneous reactions and homogeneous catalysis

which are mentioned on the fly-leaf to Volume 6 as being innovations in the new series to give greater emphasis to physical chemistry. These articles are definitely more suitable for a text-book on pure physical chemistry. An applied chemist will find that a reasonable appreciation of the fundamentals of aerodynamics together with diffusion theory will be far more helpful in actual practice than the theoretical material given under the heading of heterogeneous reactions. Hydrogen ion concentration has very many and varied applications in industry, and books have been written on the subject. Here, however, it is dismissed in a short notice on how it can be measured.

This lack of attention to the word "Applied" on the title-page is shown in other ways. Practically no attention is given to the economic side of chemical manufacture. As an example, the article on glucinium might be taken. If anyone wished to manufacture beryllium at the present moment, he would be ill advised to think that the information given him in Volume 6 of this dictionary is sufficient for his purpose.

It is invariably advisable when adopting an applied process to make a thorough search of the patent literature. It would therefore be more comparable with commercial conditions if the patent references outnumbered the others. Actually, the reverse is the case.

There would seem to be a requirement for a simple statement to act as a guiding principle in applied chemistry. The physicist has, for example, Fermat's principle, which states that, "The path of a ray of light from point to point is always such that the time taken by the light to traverse it is a minimum". Similarly, in the realm of mathematics, we have the names of Maupertuis and Hamilton and the Principle of Least Action. In applied chemistry the principle could be stated as, "The production of one chemical compound from another will follow such intermediate stages as result in the time taken to make a unit quantity of the product being reduced to a minimum".

This statement might sound like a platitude, but experience goes to show that its importance is only very slightly understood even in circles where the level of intelligence on other matters is very high. The phrase 'time taken' requires perhaps further definition. The time taken in manufacturing the plant for carrying out the reaction, the time taken in producing the energy supplied to the reaction in the form of electricity, steam, etc., and the time which is covered by the various items of chemical works costing are all best expressed by a monetary value which allows the time factor to be expressed in comparable units. The expression 'man-hours' is possibly the more justifiable unit but is not necessarily so easy to compute.

The outstanding feature of Volume 5 is the collection of articles on fibres. They include "Cotton" by Dr. A. J. Turner, "Rayon" by J. M. Preston, "Finishing Textile Fabrics" by E. Clayton, "Animal Wool" by Dr. J. B. Speakman, "Vegetable Fibres" by E. L. Hill, and "Silk" by Dr. C. S. Whewell. These articles also raise a point of interest to the general reader seeking information. Would it not have been better to have preceded this collection of articles by a short introduction on the industry as a whole and the meaning of the numerous technical terms used in it? Nearly all the ancient industries such as textiles, leather, brewing, etc., have a wealth of technical words which do not appear in the usual dictionaries and which therefore need defining for the non-expert. Thus under "wool", we read about wool quality as estimated by the grower and referred to as "60's–64's Cape Merino wool", but how does the grower estimate the wool, and why does he use these numbers? What is meant by "denier" and "counts"? How does the length and thickness of the fibre affect the subsequent processing? Perhaps a Baer diagram might help the novice. What are the principles which affect the wearing properties of the textiles? Why are some cold and some warm to wear? Why do some crease and some drape? It might be argued that these are not chemical problems, but they are at least the qualities which ultimately influence the direction of the policy of future development of all chemically produced fibres. Attention should also be directed to an extensive article on glass by Dr. H. Moore, others on fuel by Dr. G. W. Himus, and on coal and water gas by Dr. H. Hollings and E. G. Stewart and W. A. Voss respectively. Under fermentation, the late Sir Arthur Harden writes on the alcoholic side, Dr. J. H. Birkinshaw on mould and Dr. M. Stephenson on bacterial. Other articles worthy of mention are on fertilizers, by Dr. B. Dyer, formaldehyde, by Dr. H. M. Stanley, and fluorine, by Dr. H. J. Emeléus.

Volume 6 also contains a number of interesting articles, especially those by Dr. E. H. Rodd on indigo dyestuffs, Drs. E. Lewkowitsch and H. E. Cox on glycerine, H. S. Coles and Dr. P. H. Sykes on hydrogenation, Sir T. K. Rose on gold, W. H. Hoffert on gum inhibitors, Dr. D. Burton on glue, Prof. G. A. R. Kon on hormones, Dr. C. A. Mitchell on ink, Drs. J. A. Kitchener and M. Carlton on hydrogen peroxide, Dr. R. Holyroyd on coal hydrogenation, and Dr. A. J. E. Welch on helium. The article on grassland by Dr. J. A. Hanley might well have been expanded in view of the importance of its proper utilization and of the drying of grass for storage in relation to the agricultural economy and self-sufficiency of the nation. Similar comments might be made of A. G. Pollard's articles on gooseberry, grape, grapefruit, honey and huckleberry, even after allowing for the nostalgic feelings they engender after these years of war.

M. B. DONALD.

NEW LIGHT ON TELEPATHIC PHENOMENA

Experiments in Precognitive Telepathy
By S. G. Soal and K. M. Goldney. (*Proceedings of the Society for Psychical Research.* Part 162, December 1943.)

THE experiments here described, which were conducted by the authors during about two and a quarter years, are some of the most interesting and suggestive hitherto recorded. For a number of years the Society for Psychical Research has been supporting a number of experiments in the field of what has been called 'extra-sensory perception', and gradually a mass of evidence has been accumulated which is throwing a good deal of light upon phenomena which have been perhaps some of the most hotly disputed in the whole field of recent work in psychical research.

Generally speaking, the essential core of the experiments consists in the examination of the scores

attained by 'guessing' symbols or pictures in sets of five cards for convenience of statistical analysis. In a number of these tests the subject tries to guess the symbol or picture on a card that is being looked at by an experimenter seated in an adjoining room, his score being later examined to ascertain if he had attained more correct hits than the theory of probability would predict.

Now since the experiments were first started, there has been a very large volume of criticism designed to expose alleged sources of error in the actual work and faulty employment of statistical theory in evaluating the results. In the present series it would seem, judging from the record presented, that such criticisms would be beside the point. Rarely has such scrupulous care been exercised to avoid all possible source of error, and the statistical methods employed were so simple that attempts to discredit them would probably be a waste of time. Moreover, some of the results obtained excluded by their very nature many of the commonly alleged sources of error, and at the same time revealed some surprising effects which had been suspected and later proved to have occurred in previous experiments.

In the past, the prevailing tendency was to study the success obtained by the percipient in guessing the symbol which was being contemporaneously looked at by the agent. In a number of such cases it seemed that certain subjects were successful in scoring over a considerable period many more correct hits than the theory of probability would lead us to expect. But at the same time it appeared that when the records were carefully examined, the 'successes' were not always of the 'now or never' type, but a kind of displacement occurred both backwards and forwards; so that it seemed that at times the card images were becoming known to the percipient before the agent himself was consciously aware of them.

In the present series of tests this phenomenon is further examined, since the subject with whom the work was done appeared to find it easier to score hits, not on the card that was being looked at by the agent, but on the cards which immediately precede or follow it in sequence. The normal rate of guessing varied between limits of 50 sec. and 80 sec. for twenty-five calls, but when this rate was speeded up the cognition of the card in advance of that being looked at by the agent was replaced by a cognition of the card *two ahead* of the one being concentrated upon. This very remarkable effect is in itself sufficiently surprising, while at the same time it disposes of much of the criticism which might have been valid in badly conducted experiments where scores were solely confined to the card being looked at by the agent.

The theory that these effects are due to chance coincidence is considered by the authors of the reports to be completely untenable. For example, to take the one-ahead or precognitive (+1) guessing only, the results are highly significant, for the excess is equivalent to 13·6 standard deviations with odds of more than 10^{35} to 1 against chance.

In discussing the interpretation of these phenomena the authors very wisely make no attempt to deal in any way fully with their psychological and philosophical implications. It is clear, however, that if the results be upheld, light may be thrown not only upon our ideas of time but also of the nature of memory; and moreover, it seems that the earlier and naïve ideas of 'thought-transmission' may have to be abandoned. In any event we have here another step forward in the design of experiments of this kind, and the authors are to be congratulated upon their arduous labour, their scrupulous care in conducting and recording their work and their wisdom in not attempting facile explanations to describe the nature of phenomena the meaning and interpretation of which are likely to elude us for a long time to come.

E. J. DINGWALL.

EARLY SPANISH POSSESSIONS OF THE NEW WORLD AND FAR EAST

Compendium and Description of the West Indies
By Antonio Vázquez de Espinosa. Translated by Charles Upson Clark. (Smithsonian Miscellaneous Collections, Volume 102, Pub. 3646.) Pp. xii+862. (Washington: Smithsonian Institution, 1942.)

If one has a complaint against the editor and the producers of this important work, it is that the title is seriously misleading. Mr. C. U. Clark has provided a most informative introduction, and there is a very full index. The main body of the text, running to nearly 800 pages, is a translation of a manuscript in the Vatican. The original, written by Antonio Vázquez de Espinosa, for the Council of the Indies, was called a description of the Indies and dealt with all the Spanish territory in the New World as well as that in the Far East. We have here, therefore, a detailed account of a large part of North, Central and South America, the Philippines and Moluccas as well as what are now known as the West Indies, as it was about the year 1620.

It is impossible in a short review to do more than allude to the many interesting features of this work, only a small part of which has been previously published. There are valuable details of discovery, with a new account of the notorious Aguirre. Natural phenomena, like earthquakes and floods, trees, cultivated plants, mineral resources, the customs of the native population, and full details of the Spanish colonial administration fill the pages of Espinosa's work. He was a Carmelite missionary and was therefore naturally interested in church matters: and education figures largely. But there is no undue praise of what the Spaniards had accomplished. His descriptions of depopulation, "a general curse in the Indies", neither conceal the facts nor avoid the inevitable consequences, though not all were attributed to misconduct or bad administration. On the other side of the account are the constructive works of the Europeans. The great city of Lima, for example, known as The Kings, founded in 1533, is minutely described, with its irrigation works, its water supply, its rectangular blocks of buildings separated by wide streets, its four plazas, its government buildings, churches, ecclesiastical dignitaries, convents, nunneries, hospitals, university, colleges, and, two leagues away, across an arid plain, the port of Callao with its garrison, shops, stores, mills, and a good, safe harbour "free from shipworms", for "the sea water is so cold here that they chill beverages in it".

Such descriptions, with immense detail of great interest, are frequent. In short, this work will provide historians and naturalists with invaluable information on all parts of the old Spanish colonial world.

J. N. L. BAKER.

ORIGIN AND ACTION OF DRUGS

By HENRY McILWAIN

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DETAILED study of the action of drugs constitutes pharmacology, but it is doubtful whether study of their origin has reached the level of a scientific subject, though it is described by materia medica or pharmacognosy, and incidentally by biology and chemistry. It is the object of the present survey of therapeutically active substances to show that both their actions and, of naturally occurring drugs, their origins, have additional significance when considered together as aspects of comparative biochemistry.

Attempts to find theoretical connexions between the sources and the properties of drugs have been made many times during the past five hundred years. The subject greatly interested the early naturalists and carried to their work the practical stimulus of possible application in medicine. In pre-scientific times, writers of the early herbals (for example, the German Herbarius[1] of 1485) saw in the fact that mineral and plant products affected animals an indication of a common divine origin of all Nature and expressed the mode of interaction through the four elements; but their outlook had not the objectivity necessary to a scientific study. Among working hypotheses it appears to have supported mainly astrological beliefs and the doctrine of signatures[1,2] which were of value to medicine only in so far as they led to investigation of the virtues of plants.

Certain more objective connexions between the medicinal properties of some plants and their own structural characters have been incorporated in various botanical classifications, and many are still recognized as valid. They are of more significance to our present study, though they offer only a partial solution to it. When medical aspects of botany constituted a major part of the subject, classification of plants was frequently on the basis of their medicinal properties. Other affinities between plants were, however, obvious, and some of these—the petal arrangements of crucifers, or the type of inflorescence of the Compositæ—formed the beginning of natural classifications. There was a significant intermediate period when, in the same volume, some plants were grouped according to structure and others according to their use—a period when botany was beginning to develop as a subject in itself, but was maintaining a close relation to medicine. As the natural classification of plants evolved, the part played by medicinal virtues as differentiating characters declined, though even in Linnæus's rigid system it was evident that a certain connexion existed between morphological and medicinal properties. This was, understandably, emphasized by Linnæus and his protagonists[2,3,4] as being a valuable outcome of the study of taxonomy. The later, more fully developed, natural classifications could claim even closer connexions with the properties of plants, and these were expressed by A. L. de Jussieu and especially by A. P. de Candolle[4]. De Candolle was, indeed, able to use therapeutic properties as differentiating characters in a few debated instances in taxonomy. It is interesting to us now to note that this aspect of comparative biochemistry was contemporary in origin with the present biological classifications.

As biology and chemistry grew as subjects in themselves, such connexions tended to be forgotten and it was considered surprising that a morphologically based classification should receive support from the comparative biochemist[5]. This was especially so at the end of the last century, when many botanists and chemists referred to alkaloids as waste products: they were neither fish, flesh nor fowl to the fat, carbohydrate and protein biochemistry of the day. Since then, ecological studies have tempered such opinions; and alkaloids, glycosides and other substances of pharmacological action have been more generally credited with defensive or offensive powers of value to the organisms producing them. This aspect had indeed never been entirely lost, but higher plants and animals are now realized as being far from alone in producing materials deterrent to the growth or predation of other organisms. Recent studies of mutually antagonistic relations between micro-organisms have added further examples both to this very general phenomenon and to practical therapeutics. But what is the basis for this mutual interaction? When such processes exist, they may be of value to the organisms producing the inhibitory material, but not all such interactions can be regarded in this way. Often the materials are produced only under peculiar conditions of growth, or are highly active against organisms with which they do not normally appear to come into contact. That this is so may indicate only our ignorance of details of their past or normal existence, but many minor interactions take place between organisms not usually credited as antagonistic; and such interactions can be in the direction of either antibiosis or symbiosis according to environmental conditions. Are we then to regard the interacting materials as chance metabolic products—an elaboration of the suggestion of alkaloids being waste products[6]? If so, why should the interaction of product and organism be so universal? There are general similarities between fundamental processes in most living organisms; but what basis do these give for expecting antagonistic relationships?

Let us approach the problem by returning to an earlier point. The possible protective value of a compound to an organism provides a basis for natural selection of the organism producing it, but not for the origin of the compound. Sometimes, inhibitory compounds bear resemblances to other naturally occurring compounds of known biochemical importance; at other times, a given compound itself has either stimulating or inhibiting properties under different circumstances—in different organisms, or in different concentrations[7]. It is upon the basis of such relationships to metabolic processes, both in the organism of their origin and in that upon which they act, that the present account will consider the origin and action of biologically active substances, including those which have found application as drugs.

A General Basis for Pharmacological Action

Drugs are, or owe their activity to, chemical substances; the preparation of the virtues of plants in defined form, amenable to exact study, was a major result of early applications of chemical methods to pharmacology. The late nineteenth century application of physics and chemistry to the study of the action of drugs was not so secure; the peculiar characters of drugs are exhibited primarily towards living organisms, and the correlations suspected between these characters and the physical and

chemical properties of the agents exist but are relatively limited in extent. Their discovery seemed an immense progress, and its contribution to the impression that drug action was one of material interaction with living cells was an important one; but such correlations left untouched the major problem of how a minute quantity of a *substance* could affect a living *process*. The solution of this problem required a further analysis of living processes. Thus, early workers in chemotherapy and pharmacology attempted to consider the actions of drugs in terms of their affecting the known vital processes of nutrition and respiration[8]. This left the mechanism of the required connexion entirely hypothetical; a closer analysis was required to find the systems, peculiar to living organisms, which were affected by drugs and were of types as varied as the receptors of pharmacology would suggest.

Such analysis has proceeded indirectly and is connected with our present subject through the following steps. (*a*) The classical drugs represent only one type of chemical substance capable of specific interaction with living systems. It is a major characteristic of other reactions between substances and processes in living organisms that they commonly occur through, or under the control of, enzyme systems. In intermediary metabolism, the necessity for magnesium salts in fermentations, for flavine nucleotides in amino-acid oxidation, for iron-porphyrin compounds in reactions with hydrogen peroxide, have been found due to these substances forming parts of specific enzyme systems. (*b*) Following upon the recognition of the importance of enzymes in living processes, certain pharmacological agents were demonstrated to owe their specific effects to actions upon enzyme systems (see below). (*c*) Many substances of critical importance in intermediary metabolism are of widespread natural occurrence and can function in organisms other than those in which they originated; and both in the organism of their origin and in those in which they secondarily act, they are connected with enzyme systems. This is true not only of the general categories of carbohydrate, fat and protein but also of substances more akin to classical drugs in their potency and specificity of action. Thus aneurin functions in pyruvate metabolism both in the yeasts and bacteria which synthesize it and in the animals to which it is a vitamin; similar details can be given of nicotinamide and riboflavine derivatives.

The following paragraphs present evidence for a basically similar, though more complex, state of affairs with respect to pharmacological agents in general. The first two points relate to the natural occurrence of biologically active substances, and the latter two to the behaviour of such substances in biochemical systems.

(1) *The quantities of such substances produced by different organisms, or occurring in different parts of them, are very variable.* It is not surprising, or important in the present connexion, that this should be true of carbohydrate or fat; the significance arises in the variable occurrence of substances of more specific action. This is especially well documented with respect to vitamins. Compilations[9] of the vitamin contents of foodstuffs (mainly organs or tissues of higher plants and animals) show variations of many hundredfold and frequently to 10,000-fold in their contents of vitamins A, B_1, B_2, C and of substances of vitamin D activity. This assessing discounts materials described as possessing only 'traces' or 'none' of the vitamins, and does not include values for prepared materials such as bread or oils; the range is thus minimal. Relatively few micro-organisms have been examined in this way, but considerable variations in vitamin production between only six species of bacteria are reported by Williams[10]. Yeast strains can vary considerably in their production of such substances[11].

(2) *In different species, a given function may be performed by related, and not identical, substances or processes.* A classical example is the different forms of excretion of nitrogen in mammals, birds and teleosts, when physiological reasons for the differences can be suggested[5]. They are necessarily associated with differences in the enzymic make-up of the tissues of the different animals, notably with variations in the occurrence of arginase. Again, creatine phosphate in the muscles of vertebrates is replaced by arginine phosphate in the invertebrates. The varying pyrrole respiratory pigments of vertebrates, molluscs, and annelids afford further examples. Among processes, interesting differences exist in the enzymes oxidizing glutamic acid in animal tissues and in yeast, which require respectively coenzymes I and II[12]. Detoxication of benzoic acid can be by glycine or ornithine, and of phenylacetic acid by glycine or glutamine, in different—often closely related—species[13].

(3) *A substance normally essential to a particular process may, by being present in excess or under different conditions, inhibit the process.* Examples of the inhibition of enzyme reactions by excess substrate or products are common[14], and have been given as a basis for many of the following processes of whole organisms. In microbiology: 10^{-7} *M* nicotinic acid is necessary for growth of dysentery bacilli, but higher concentrations inhibit it[15]; small quantities of *p*-aminobenzoic acid, preformed or synthesized by the organism concerned, appear necessary to many micro-organisms which are inhibited by higher concentrations[16]. A given amino-acid (threonine, valine, leucine) may promote or inhibit growth of *Bact. anthracis* or a Neurospora strain according to the nature and quantities of other amino-acids present at the same time[17]; in these cases the balance between stimulation and inhibition is extremely delicate, and small structural changes or concentration differences have very large effects. The phenomenon is also found in growth of *Proteus morgani*[18]. Rats are injured by diets of high tyrosine content[19], though the substance is a constituent of their proteins. Ill effects following excessive vitamin intake may also be quoted; hypervitaminosis-D (and probably -A) have been reported, the latter instance[20] being of especial interest as it was observed in man and rats following ingestion of natural foodstuffs and not of a concentrate.

(4) *The processes associated with a given substance may be inhibited also by substances structurally related to it.* Again, this is well-documented in enzyme reactions[14], succinic dehydrogenation being inhibited by malonate; dehydrogenation of lactate, by other α-hydroxyacids; hydrolysis of fats, by alcohols and phenols, and of peptides, by other amino-acids. Transamination between keto-acids and amino-acids is inhibited by certain fatty acids[21]. The phenomenon also occurs in growth of micro-organisms[7,8,22], when the growth-promoting effect of nicotinic acid may be prevented by pyridine-3-sulphonic acid; of aliphatic aminocarboxylic acids, by aminosulphonic acids; and of pantothenate, by pantoyltaurine and by a number of other analogues. Inhibition by indole-

acrylate is annulled by tryptophan; that by ethionine, by methionine. Such effects may also be reproduced in higher organisms[23] by analogues of vitamin B_1, of vitamin C, and of the anti-hæmorrhagic K vitamins. Actions in many of the more complex systems have again been referred to enzymology.

Biological Interactions in Relation to Pharmacology

The apposition of paragraphs (1) and (2) with (3) and (4) leads to the following conclusion: that known properties of enzyme systems, and the observed variations in the occurrence and structures of metabolically functioning substances of living organisms, provide a basis for processes in one organism being affected by products from another. This does not exclude other bases for such actions; but is sufficient to suggest pharmacological action to be inevitable. If, however, the above factors were the only ones to be considered, such action would not be expect d to be associated with many characters which are, in fact, observed. Detoxication mechanisms in animals and the association of substances of pharmacological effects with special structures (in nettles or snakes) emphasize that biological interactions have not been taken into account. Pharmacology is concerned with aspects of the behaviour of animals which have evolved while dependent upon other organisms for food, and of plants to some extent dependent upon animals for fertilization and dissemination. All can persist only in so far as they maintain their own characters in spite of, or through, their relations to other organisms and to their environment in general. The connexions, discussed earlier, between the position of some organisms in natural classification and in content of pharmacologically active agents presumably persist because such agents are of value to the organisms producing them.

Two types of behaviour can be recognized as developed from the simple, inevitable type of interaction to be expected from paragraphs (1) to (4). First, both animals and plants elaborate agents which are much more potent in their damaging or obnoxious properties than are, for example, vitamins. Secondly, animals react to a large number of deleterious substances by not assimilating or by rapidly excreting them; and by changing them to non-toxic substances by combination or breakdown. Many of the detrimental interactions with potential drugs are thus normally avoided by the various means by which organisms are found to maintain their independence, but the procedures of isolation and administration of drugs are ones which would be expected to break down such independence. A particular tissue, organ, or substance is commonly selected and put to intimate contact with a wound, the eye, alimentary tract, or bloodstream of the animal receiving the drug. Micro-organisms, during their growth in common media, are in particularly intimate contact and are found to exhibit mutual interaction to a high degree, both in the sense of symbiosis (for example, through the production by one organism of substances which must be obtained pre-formed by the other) and antibiosis (for example, in the production of gramicidin, penicillin, or iodinin, which inhibit the growth of many other organisms).

A General Classification of Therapeutic Action

The present account has suggested a common basis for the actions of a wide range of substances in pharmacology and related sciences. This is amplified in the table opposite, which compares the activities of typical pharmacological and physiological agents such as eserine or phloridzin with acriflavine, microbial antibacterial agents, vitamins and hormones. The latter groups have an uncertain place in current text-books of pharmacology, though some authors have welcomed them as filling gaps in the 'materials of animal origin' left by extrusion of less delectable items of the older materia medica. Biochemical localization of drug action is in many cases still a subject for debate and research, and the types of action given cannot be exhaustive. The following points call for special comment.

(1) It is not intended to suggest that simple enzymic processes necessarily provide the basis for all therapeutic actions; obviously—as is suggested by Section V of the accompanying table—the presence of enzymes in cells is conditioned by other processes which may or may not be enzymic; also, the term 'enzyme system' has been used advisedly to include series of linked and dependent or physically associated reactions which may represent types of organization more complex than those of the typical purified enzymes, but which can be studied by biochemical methods in tissues and cells. In such studies *it is indeed especially necessary to consider the level* at which interaction with the biological component takes place[24].

(2) Enzyme reactions can be affected by means other than the supply of coenzyme or interaction with metabolite analogues, which have been emphasized in the above account; though the view has been expressed that most specific pharmacological actions are through structural resemblance between the active agents and natural substrates[25]. Certain natural antibacterial agents act through chemical reactions with enzyme or substrate: notatin[26] and milk flavoprotein[27] by hydrogen peroxide formation; penicillic acid, possibly by reaction with amino-acids[28]. These represent further types of action which make the metabolic processes of different organisms incompatible.

(3) The table presents a classification according to the systems upon which the drugs act. The present account has emphasized that in the case of naturally occurring agents this is one side only of a more complex interaction, and that to characterize fully such a drug it would be necessary to consider its relationship to systems in the organism of its origin. Synthetic drugs exhibit no such dual relationship. This provides one reason for the present classification according to the system affected by the drug. A second reason is that, *even among natural drugs, the occurrence of* many can be considered to be more related to the system which they affect than to that in which they originate, in so far as their perpetuation as defence mechanisms is accepted. The two aspects may be illustrated by, on one hand, snake venoms, which would appear to owe their present existence in snakes to their effect upon higher animals; on the other hand, it is more doubtful whether this is the case with toxins of bacteria the normal habitat of which is soil, as with *Clostridium tetani*.

With respect to synthetic drugs, the large number of compounds empirically prepared before a successful drug is discovered is only too evident; it has been generally realized, and expressed in the receptor theories, that this process was one of finding molecules to fit somewhat elusive structures in living cells. Such is the basis for the practice of using as guides almost any compound of natural occurrence, of

pharmacological action, or with the evident powers of combining with cells which are shown by certain dyestuffs. Greater knowledge of functioning systems in organisms can be expected to provide increasingly more direct methods of preparing compounds of desired activity; but it must be emphasized that the cinchona tree, for example, has had the experience of many millennia longer than humanity in dealing with organisms related to that causing malaria, and that the foregoing arguments suggest reasons for its having a shrewd initial measure of its opponent. For such reasons natural drugs can be expected to set high standards in their efficacy.

(4) It is inherent in the present thesis, and in the table, that an organism is a balanced system, the ordinary behaviour of which can be disturbed by either excess or deficiency of normal constituents or functions. Thus the promoting of an enzyme process by a drug, or any other of the actions I to V of the table, may result in either disturbance or readjustment of a system. When the system is the more complex one of chemotherapy, concerning host and parasite, the two processes are proceeding simultaneously in its different biological components. Though in this case the components can be relatively easily separated for experimental demonstration of the action of the drug upon each of them individually, agreement upon which is primarily affected by the drug has in many cases not yet been reached[29]. Comparable problems are encountered in the study of hormones and morphogenetic factors in higher organisms. It may be possible to suggest whether the primary action is one of stimulation or inhibition by the range of compounds producing given effects. It was found[22] that a much wider range of molecular type was compatible with substances acting as inhibitors than with their acting as promoters of reactions, and in explanation it was pointed out that in the first case it was requisite only for the substance, for example, to combine with an enzyme, while in the second case both combination and subsequent specific changes were necessary.

(5) Many drugs have more than one action, susceptible in some cases to differentiation at both pharmacological and biochemical levels. A given biochemical effect, however, would itself lead to varying pharmacological effects with varying location of the system affected. Chemotherapy, again, offers interesting examples in the actions of the sulphonamides, which by inhibiting a pathogen can prevent the production of, for example, hæmolysins and death of the host; but by inhibiting normal intestinal micro-organisms can *cause* nutritional deficiency and again a hæmatological disturbance in the host[30]. The actions have characters in common which suggest their biochemical identity. Such complexity emphasizes that considerations of the present type provide only one link, though the primary one, between the administration of a substance and the final therapeutic response.

CLASSIFICATION OF TYPES OF ACTION IN PHARMACOLOGY AND RELATED SCIENCES

Explanatory notes are given in square brackets; round brackets indicate that the allocation of the effect to a particular class is speculative.

Action through:		Examples in which the normal function of the subject is:	
		Restored or maintained	*Disturbed*
I. Promoting enzyme-processes	As coenzyme, or important part of it	Vitamins B_1, B_2; nicotinic acid (other vitamins[31] and trace-elements) [normal effects]; (non-protein hormones)	Vitamins [in hypervitaminoses]
	As enzyme	Intrinsic factor of pernicious anæmia; thrombin; angiotonase, renin[32]; (protein-hormones)	toxic plant proteases[42]; anti-B_1 factor of carp[43] [relation to fox and chick]. *Cl. welchii* toxin[44]; snake venom [relation to intoxicated animal].
II. Inhibiting enzymic or analogous processes	By combination as substrate, coenzyme, or analogue	sulphanilamide, pantoyltaurine[33] [overall effect in chemotherapy]; prostigmine, physostigmine[34]; (ephedrine, cocaine)[25,35]	sulphanilamide, pantoyltaurine[33] [effects on parasite in chemotherapy]; (avidin)[45]; CO; phloridzin.
	By other combination	acriflavine[36] [overall effect in chemotherapy]	acriflavine [effect on parasite] (phytic acid)
	Through biochemical action		guanidinoacetic acid[47]; alcohol[48] [some effects on other systems through lack of labile methyl groups and vitamin B_1]; notatin[26].
	Physical changes		narcotics [certain actions due to protein denaturation][37].
III. Removing inhibition of enzyme systems	Supplying coenzyme or substrate	*p*-aminobenzoate, pantothenate[33] [effects on parasite in chemotherapy with sulphanilamide and pantoyltaurine]	*p*-aminobenzoate, pantothenate[33] [effects on host in chemotherapy with sulphanilamide and pantoyltaurine].
	Physical changes	light [upon CO-inhibition of iron-porphyrin systems] pressure [upon narcotized bacteria][37]	
IV. By-passing enzyme systems	Supplying product of enzyme	p.a. factor of pernicious anæmia; oxaloacetate [to vitamin B_1-deficient organisms][38]	
	Supplying material simulating enzyme	methylene-blue, phenazine derivatives[36,39] [effects on parasite in chemotherapeutic interference]	methylene-blue, phenazine derivatives[39] [effect on host in chemotherapeutic interference]
V. Altering or destroying enzyme system or components		pantoyltaurine-resistance in *C. diphtheriæ*[40]; NaF-resistance in *Propionibact. pentosaceum*[41] (other drug resistance) [by biological reaction to environment]	some effects of heat[49] and irradiation[50] [direct effects of environment; restored by coenzymes or nutritional factors].

Conclusion

We have now the privilege of building upon the empirical findings of pre-scientific workers; upon the wholesome activities of those who swept pharmacy clear of magic and confusion; and upon the freshly gathered though still largely empirical results of the past fifty years. This paper has attempted to acknowledge our debt to each of these classes of investigator but in particular to connect the wider aspirations of the first with the experimental findings of the last of these groups. To earlier workers, who produced their effect by taking material from one organism and applying it to another, it was more apparent that connexions might exist between the origin of drugs and their actions. It was necessary to separate these two aspects for their initial scientific investigation, and views narrowed. An author, while giving as his aim the discovery of the laws of interaction between drugs and cells, limited himself to physico-chemical methods and interpretations; the study of drug-antagonism was divorced from the natural origin of the drug and the antagonist; text-books of chemotherapy were arranged according to the chemical structures of the agents. A conclusion supported by this paper is that for the understanding and theoretical presentation of pharmacology and chemotherapy, biochemistry and general biology are among the most immediately relevant sciences.

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FUNDAMENTAL CONCEPTS OF NATURAL PHILOSOPHY

IN his recent James Scott Lecture, delivered before the Royal Society of Edinburgh, on "The Fundamental Concepts of Natural Philosophy" (*Proc. Roy. Soc. Edin.*, 62, Pt. 1, No. 2. Pp. 10–24. 1*s.* 3*d.*), Prof. E. A. Milne gave a comprehensive sketch of the theory of kinematical relativity which, with his collaborators, he has been developing during the last dozen years. The lecture contained no essentially new material, but it gave a very useful summary of the scope of the theory, with attention concentrated on the fundamental ideas, and its appearance marks a suitable occasion for forming an estimate of the significance of this new approach to the basic problems of natural philosophy.

The most fundamental concept of the scheme is that of the 'substratum', which is an idealized system of relatively moving particle observers, indefinitely numerous and each provided with a clock which he can graduate, in the first instance at pleasure. All such observers can send beams of light to the others and receive them back, by which means they become aware of the readings of the others' clocks, and they agree so to graduate their clocks that, for every pair of observers, A and B, "the totality of observations A makes on B coincide with the totality of observations B can make on A". They are then said to be "equivalent". Now suppose they wish to observe an external object. Each observer must (*a*) emit a beam of light at a time t_1 by his clock, and (*b*) observe his clock reading, t_2, at the instant at which he thereby observes the object. He must then form two specified independent functions of t_1 and t_2, involving the choice of a particular value for a conventional constant, c, and these functions he calls the *distance* and the *epoch*, respectively, of the object. Successive observations give a series of values of distance and epoch, and the relation between these constitutes the equation of motion of the object. The *law* of motion (or law of gravitation in the general case) is then determined by the condition that the totality of motions in the universe shall be described in the same way by all substratum observers; that is to say, if A observes an object at

distance r and epoch t as determined by his clock, B must also observe an object (not necessarily the same object) at distance r and epoch t as determined by *his* clock. "Gravitation", writes Prof. Milne, "is only the name given to the inevitable way in which particles must move in one another's presence and in the presence of the rest of the universe, if they are to move according to the same rules for all equivalent observers in the universe".

The function of the substratum is thus to provide a stage for the display of natural motions; it corresponds in this theory to Euclidean space in ordinary geometry or to space-time in Minkowskian kinematics. It is not something which actually exists in the naïve sense of the phrase, but a conception which serves to determine the form in which observations of actually existing bodies shall be tabulated, and to define the sphere of possibility of actually occurring motions. "The theoretical, the ideal, the abstract substratum", writes Prof. Milne, "this system of moving particles, monads, observers . . . possesses a great many strange and surprising properties. . . . Just as the Euclidean plane is the stage, the scene, the background against which the phenomena of geometry—its figures and its theorems—display themselves, so the substratum is the background against which the phenomena of dynamics and gravitation display themselves".

Against this background, then, the actual bodies of the universe are to be contemplated and their behaviour observed, and here we encounter an ambiguity which I have invariably felt in reading Prof. Milne on this subject, and which remains unresolved here. Just as the Euclidean character of space tells us nothing about the number or distribution at any moment of the objects observable in space, so one would expect that the characteristics of the theoretical, ideal, abstract substratum would tell us nothing about the number or distribution of practical, real, concrete objects which present themselves for description in terms of it. This, however, appears not to be so. The behaviour of a free particle is determined not only by the demands of the observers in the substratum, but by the "rest of the universe"—that is, all the other concrete particles—also: and, furthermore, the "rest of the universe" is controlled, in both content and behaviour, by the condition that the substratum observers shall give the same general description of the whole. When one asks the reason for this, however, the answer is puzzling. We cannot deduce the motion of a single free particle without considering the rest of the universe, says Prof. Milne, for "if we are asked what is the motion of a free particle in 'empty space', *i.e.* in the presence of one observer alone, the question is an illegitimate one, and we cannot answer it". But we do not ask what is the motion of a free particle in the presence of one observer alone, but what is the motion of a single concrete particle in the presence of all the ideal substratum observers, and no reason is given why we cannot state it. We can only assume that the universe cannot contain only a single particle, because if so the substratum observers could not give the same account of it; but it would have been more satisfactory if this had been plainly stated.

The theory proceeds to deduce the way in which the universe must be populated with concrete bodies, and how those bodies must move in one another's presence, in order that it shall conform to the requirements of the substratum. This, of course, involves much mathematics, of which the chief conclusions are given in the lecture, and we reach a point at which the resulting "law of gravitation" can be compared with the familiar Newtonian law. The classical "constant of gravitation" turns out to be a function of time, but it can be made to "masquerade as a constant" by a transformation of the time-scale to that used by Newton. The deductions of the theory, however, are at present of less interest than the foundations, and we turn to an examination of the fundamental postulates.

It must be admitted that Prof. Milne speaks no more than the truth when he describes the substratum as possessing strange and surprising properties. We have become accustomed to 'spaces' which turn back on themselves and do other queer things, and it is an axiom of general relativity that the properties of space vary with its material content—that space, in fact, is less aptly described as a frame into which bodies must fit than as a garment shaped to their figure. But of all previous thinkers who have taken liberties with space, none, so far as I know, has given it intelligence. The substratum, however, is *essentially* intelligent. Each particle of it is necessarily accompanied by an observer—*is*, in fact, an observer, since it has no function but that of observing, recording and calculating. "Observers are an essential element in the situation", writes Prof. Milne. Nor is "observer" here merely a picturesque term for "observing instrument", as in the popular accounts of Einstein's relativity. The substratum observers must not only record the pointer-readings of clocks; *they must also agree to give the same value to a conventional constant, c*, otherwise their readings are useless. This cannot be done without communication by means of an agreed conventional language, and for this minds, and not merely instruments, are essential. We cannot escape from this, nor, apparently, does Prof. Milne wish to do so, for he states as one of his two principal motives throughout the work, "the attempt to say exactly what is meant by a quantitative statement in terms of operations that could be actually carried out, and communicated to a distant observer elsewhere in the universe, who could repeat similar observations, on these instructions, himself".

Parenthetically, it is worth while to point out a common misunderstanding, which Prof. Milne seems to share, concerning the meaning of 'observer' in Einstein's theory of relativity. It is often said that the purpose of the theory is to reconcile observations of observers in relative motion. That is a mistake, arising from a well-meant but unfortunate device widely adopted for explaining the theory in an attractive way. What the theory actually does is to prescribe how a single observer must change his measure numbers when he changes his co-ordinate system; for example, when (absolute motion having no significance) he changes his arbitrary standard of rest from one body to another. As a theory based on experience it can obviously do no more, for we have measurements of only one observer—a terrestrial one. The Michelson-Morley experiment did not compare observations by terrestrial and solar observers. It showed that the single result obtained by a single observer was to be expected, no matter whether that observer regarded himself as at rest or as moving round the sun. Of course, we can deduce what the theory would require a solar observer to measure if he used the same kinds of instruments and the same rules of calculation as ourselves, and the

deduction, like any other, might turn out to be incorrect if we ever succeeded in observing a terrestrial experiment from the sun. In that case the theory would have to be revised. The essential point is that hypothetical observers play no part in the theory *per se*. Anything we may say about them has the character of a scientific romance.

If the substratum postulate referred to above were shown to issue in the actual laws exhibited by moving bodies, and to form a simpler axiomatic basis than any other so far devised, it would have to be given serious attention. We might try to reformulate it so as to bring it more into line with general physical convention, but if we failed to do so, no plea of apparent absurdity would justify its rejection. We have learnt—or should have learnt—by now that nothing is too fantastic (that is, contrary to expectation) to be true. But this would not at all win Prof. Milne's approval, for it would subject the postulate to the test of *experience*, and its significance to him is that its validity is *beyond* experience; the postulate is advanced as self-evident and inevitable. The other of his two principal motives already mentioned is "the desire never to introduce, unsuspectedly, any elements of *contingent* law". He proposes in his lecture to show how "we are led to quantitative laws relating phenomena in the external world which are *inevitable* [my italics] relations between the elements of perception". "The more advanced a branch of science", he writes, "the more it relies on inference and the fewer the independent appeals to experience it contains. . . . The question arises as to whether this process of inferring can come to a stop, and if so, where. Is there an irreducible number of brute facts derived from observation? . . . The answer seems to me to be that we can reduce the appeals to *quantitative* experience to zero".

My mind must be made on a different pattern from Prof. Milne's, for the necessity of the substratum as a background for phenomena does not appear to me at all self-evident. I find myself capable of doubting the possibility of existence of the army of equivalent observers, of doubting their significance for natural philosophy or anything else if they did exist, and of doubting the ability of stars and planets to know where the decisions of the substratum conference required them to be. I have a conviction that, like Adam in Blanco White's sonnet, I should not have known that the universe contained numerous bodies outside the earth if no one had observed them. I am not persuaded that Einstein "still relied on an empirical assumption—the constancy of the speed of light—in his derivation of the Lorentz formulae, not realising that the same ideas could be developed further so as to dispense with this assumption". It seems to me that this "empirical assumption" was nothing more than a statement of the time-scale adopted in relativity theory, just as Newton's First Law of Motion is a statement of the time-scale adopted in classical theory, and the substitution for it of an animistic philosophy in which the same constant is adopted as a convention by hypothetical observers instead of as a unit of measurement by actual ones seems to me neither an improvement nor a logical necessity. In short, while I am perfectly ready to adopt Prof. Milne's postulates as an axiomatic basis for physical theory if he can show that they lead to a simpler and more comprehensive correlation of experience than any other, and very much hope that he will be able to give his voluminous and elegant mathematical work some acceptable meaning, I retain sufficient imagination to conceive, and liberty to choose, postulates of very different character.

Finally, I find it impossible to understand what Prof. Milne means by his claim that he has said "exactly what is meant by a quantitative statement in terms of operations that could be actually carried out". Having, through the kindness of the General Electric Co., recently acquired the charge of a particularly bright lamp, and having access also to a Riefler clock and other ticking devices, I felt myself in a position to become an "equivalent observer", and began to consider how I should set about deriving the laws of the universe. The first step was to send a beam of light to another such observer, but, having noted the instant by the clock at which my lamp was uncovered, and, just to emphasize its arbitrariness, decided to move that c be given the value $2 \cdot 99796 \times 10^{10}$, I found I could get no further, for the next observer failed either to pick up my beam or else to send it back to me. This, perhaps, was only to be expected, since he was theoretical, ideal, abstract, but it left me in a dilemma: I could not communicate with an equivalent observer since he did not exist, and it was useless to communicate with a possibly existing observer (say on Mars) since he was not equivalent. My clock jeered at me in the old Greenwich rhythm, and I could not even begin to measure the first distance and epoch.

What was to be done? In all sincerity, I do not know. I can understand that it *would* be possible "in principle" for me to carry out Prof. Milne's instructions if the theoretical observers existed and were complaisant, though I am not so clear why, if he can reduce the appeals to quantitative experience to zero, he makes this superfluity a principal guiding motive. But the fact is that there is still a great deal about the universe that I do not know and would very much like to know. I am prepared to accept any indirect procedure which can be shown to yield the same result as the ideal one, but Prof. Milne has described none and I can imagine none myself. So I remain unable to understand what is meant by the claim that the meaning of quantitative statements has been stated "in terms of operations that could be actually carried out".

HERBERT DINGLE.

BUDGETARY AND DIETARY SURVEYS

A WHOLE-DAY Conference of the Nutrition Society was held on February 5 at the London School of Hygiene and Tropical Medicine to discuss "Budgetary and Dietary Surveys of Families and Individuals". The meeting was devoted in the main to a consideration of different methods of conducting such surveys and their comparative value.

The Society is doing valuable work in bringing together social workers and experts interested in different aspects of the subject of nutrition and able to speak from knowledge and experience. Thus each comes to view the problems which arise with a due sense of proportion and to correct the impression which might otherwise be formed that one particular approach to a solution is all-important. As Sir John Orr, who presided, pointed out, food will occupy a key position in post-war reconstruction. The Prime Minister put it first in his Guildhall speech. It is essential, therefore, that all the relevant facts should

be assembled in good time to put before legislators. Papers were contributed by Dr. E. R. Bransby (Ministry of Health), Mr. A. G. Jones (Ministry of Food), Mr. L. Moss (War-time Social Survey), Mr. F. Le Gros Clark (Children's Nutrition Council), Prof. A. L. Bowley (Institute of Statistics, Oxford), Prof. Major Greenwood (London School of Hygiene and Tropical Medicine), and Mr. D. Caradog Jones (University of Liverpool).

A fundamental question was raised at the outset by Mr. A. G. Jones: Are household budgets suitable instruments for the assessment of nutritional welfare? In his very competent analysis of the difficulties encountered in such inquiries, a number of points were stressed to which the Conference returned again and again in different contexts. The following are typical examples: (1) If the household is the unit of measurement, the food consumed may be adequate for the household as a whole but not adequate for every individual in the household. (2) The food consumed may be adequate in the week sampled, but not adequate in subsequent weeks. (3) To measure the food actually consumed in a selected week, account must be taken (*a*) not only of the food bought that week, but also of the food saved from any previous week or kept for consumption in any future week; (*b*) of home-grown and home-made food, and of food obtained free of charge; (*c*) of food eaten from home and of food eaten by visitors; (*d*) of food wasted and food values reduced in preparation and cooking. (4) Accuracy in the conversion of food, raw and cooked, of which only the price or weight may be known, into terms of nutritional value is not easy to achieve. (5) The food requirements of individuals vary with age, sex, and other less obvious factors.

Although there are ways of meeting such difficulties, it is clear that they call for an exceptional degree of willing co-operation on the part of housewives if they are to be met at all satisfactorily. It was not surprising, therefore, that some speakers expressed doubt whether nutritional surveys of families could be of any real value. This, as Dr. Bransby pointed out in an illuminating paper on studies of food consumption, is to misinterpret the function of family surveys. Their purpose is not to provide information on individual intakes, but "to enable estimates to be made of the food consumptions and adequacy of nutrient intakes of groups of families according to such factors as income and family size". Two distinct methods were used experimentally in surveys of this kind during the early part of the War by the Ministries of Food and Health: namely, the precise or weighing method, and the log book. As a result of this experience the first method was discarded as too slow and laborious, and the log book method has now been in use with success for nearly four years. Another serious objection to the weighing method is the involved technique, which makes it practically impossible to obtain the co-operation of a properly selected random sample of housewives. Dr. Bransby and others thought that dietary surveys should become part of wider and more detailed investigations, to which clinical, biochemical, sociological, and other data could be related. For this it would be essential to make the individual the unit of inquiry. With experience thus accumulated it might be possible to ascertain the precision that can be attached to nutrient intakes calculated from prepared food tables.

Prof. Greenwood drew a distinction between nutrition studies of stable groups and those of unstable groups in the population. The fundamental aim of all such studies is to discover what he called "the energetic cost of life and work". It has been long since established and repeatedly confirmed by experiments in widely different areas that, for a stable group, the normal daily calorie intake is in the neighbourhood of 3,000 per man, with a coefficient of variation of 10–14 per cent. Accordingly, in his opinion, the most valuable type of study to be undertaken now is that of an unstable group where danger to health or growth is threatened. If the mean calorie intake falls continuously below a critical value of 2,600, or if the coefficient of variation rises much above 14 per cent, disaster might almost be predicted within the observed group. Two recent surveys of mining households in the north of England were instanced, where the calorie average was 2.830–2,860 with a coefficient of variation of about 20 per cent. Prof. Greenwood ended by stressing the necessity for a rigid application of the random sample principle in nutritional surveys.

The problem is to secure a random sample, if scientifically precise methods are to be used in determining individual needs and consumption, especially in view of the fact that among the very poor, whose need is greatest, precision is most difficult to achieve. Moreover, the psychological reactions of the individual observed may also prejudice the results by their influence on veracity or consumption. There is clearly need for experiment in this field, with small but carefully chosen groups in different parts of the country and different strata of the community, to discover the best methods of approach and the most promising technique to adopt. The results of work recently done by the Ministry of Health in collaboration with the Ministry of Food and the War-time Social Survey, of which Mr. Moss gave some account, are both interesting and useful, but this has been related primarily to administrative needs: the methods used were not exact enough for a scientific study of nutritional problems.

In contrast, the Conference had an academic exposition by Prof. Bowley of the fitting of a straight line to a set of statistics relating expenditure on a particular commodity to the total available income in a suitably selected sample of households. Such research clearly has an important place in the development of knowledge about nutritional needs and habits. Attention was directed also to the actual and calculated range of variation on either side of the average expenditure within a selected sample. In the discussion which followed, Dr. Bradford Hill remarked that there has been too great a tendency to confine records of expenditure and consumption to averages of the observations sampled. He put in a plea for the more general publication of the complete frequency distribution, so that the amount of dispersion about the average might be estimated. He took a sensible middle line between those who only favoured small samples, on the ground of greater accuracy, and those who favoured large because the small were seldom in effect random. Incidentally, Dr. Yates of Rothamsted, who had just returned from the Continent, expressed the opinion that nutrition surveys in occupied countries would be of considerable help to the administration immediately after the War if carefully planned now. He and others urged the need for greater uniformity in the conduct of surveys and the treatment of data; comparable results can only be obtained by co-ordinated team work.

The final contribution to the general discussion was a series of tables concerning human needs and related vital statistics, presented by Dr. B. Woolf of the University of Birmingham. He had prepared lantern slides beforehand, and his running commentary on each table of figures thrown on to the screen introduced a touch of light comedy into the proceedings. It was not perfectly clear whether his remarks were to be taken seriously, for he questioned in turn estimates made by Sir William Beveridge, Mr. Rowntree, Prof. Bowley, the British Medical Association Committee on Nutrition, and others, hitherto accepted as authoritative. The present writer, in the course of a paper comparing the relative amounts of family expenditure allotted to food and other commodities, had applied a slightly amended estimate of Sir William Beveridge's subsistence scale to determine the bare cost of living of a family of four persons. The estimate for food, criticized by Dr. Woolf, was based on the scale recommended by the League of Nations Technical Commission on Nutrition as interpreted in the Beveridge Report.

As Dr. Bransby pointed out later in discussion, practical and reasonable diets were drawn up in conjunction with dietitians to conform to this scale, and the diets were costed on the basis of the Ministry of Labour food prices in 1938. If such figures are not accepted, where do we stand ? In the same paper an attempt was made to focus particular attention on a practice which is perhaps not generally recognized. In estimating a subsistence standard, only the cost of food is based strictly on need ; the other figures are determined by what is customary rather than by what is strictly proved from first principles to be necessary. The cost of items other than food in the above-mentioned paper was, in fact, closely related in each case to what the poorer families in the towns of Great Britain actually do spend (not what hard-hearted statisticians think they ought to spend) on these items, judging by the best available evidence, namely, the extensive and representative sample of household budgets collected by the Ministry of Labour in 1937–38.

Sir John Orr, at the end of the meeting, reviewed the difficulties involved in making dietary surveys. On the basis of experiment there could be no doubt as to the benefit children received when protective foods were added to their diet, and the British Government is committed to the task of improving nutrition to an optimum health level. The desired standard could not be reached for some years. We should need to produce more food ourselves and to import more. The whole problem of the organization of agriculture and the prices of foodstuffs must be settled. How much will the country have to pay the farmers to produce what is necessary ? Furthermore, in estimating needs we must not be too academic. People cannot be blamed for choosing to spend on other pursuits, to enliven dreary lives, part of the weekly income which might otherwise be spent on food. The solution, he suggested, is so to adjust finance and wages that there would be enough money for all to buy food and other necessities and to leave a reasonable margin for pleasure.

The Conference is to be resumed in May to discuss the results of the analysis of diets consumed in institutions, also various methods used in the preparation and cooking of food, and the laboratory assessment of the nutritional value of meals.

D. CARADOG JONES.

OBITUARIES

Prof. Yandell Henderson

YANDELL HENDERSON, whose death at the age of seventy occurred on February 18, held in succession the chairs of physiology and of applied physiology at Yale University. Although his investigations embraced many aspects of the physiology of the circulation and respiration, he will probably be best remembered for his advocacy of the value of carbon dioxide as a respiratory stimulant in a variety of clinical disorders.

Early in his career, Henderson's attention was attracted to the problem of surgical shock and to the failure of the circulation associated with this. This, he saw clearly, must be due to failure of the venous return to the heart, but the generally accepted idea that this was dependent on failure of the vasomotor control of the arterioles afforded him no adequate explanation. He noticed, too, that the venous return and the output of the heart could be greatly diminished by undue reduction of the carbon dioxide content of the body brought about by over-ventilation of the lungs, and that the venous congestion in the alimentary tract, and the paralysis of normal peristaltic movement when the abdomen was opened and the intestines exposed, was dependent on serious loss of carbon dioxide from the tissues by diffusion into the surrounding air. He was thus led to develop his theory of a veno-pressor mechanism independent of, but supplementary to, the arterial vaso-motor system, a mechanism which was dependent on the maintenance of an adequate concentration of carbon dioxide in the tissues. Although at first he was inclined to think that the explanation of this mechanism might be found in the effect of carbon dioxide on the veins, he soon developed a much wider theory, namely, that the maintenance of an adequate venous pressure was essentially bound up with the maintenance of normal reflex muscle tonus, and the support given by this to the veins and capillaries; and that anything which interfered with muscle tonus must lead to failure of the venous return to the heart.

Henderson had a profound admiration for J. S. Haldane, but it was not until 1910 that the two met for the first time at the International Physiological Congress held in Vienna. Here they planned an expedition to Pike's Peak, Colorado, to study the effects of high altitude and the factors involved in acclimatization, and this expedition was successfully undertaken in the following year. Thenceforward Henderson and Haldane maintained a close friendship, and Henderson's frequent visits to Europe brought him into contact with others, such as Barcroft of Cambridge and Krogh of Copenhagen, whose scientific interests were similar to his own.

The publication of Haldane and Priestley's classical paper in 1905 had already established the fundamental facts of the chemical regulation of the breathing, and had emphasized the physiological importance of carbon dioxide in this connexion. The significance of this work was fully appreciated by Henderson. It was indeed in harmony with his own work on the part played by carbon dioxide in the regulation of the circulation, and in a succession of papers he made a considerable contribution to the problem of the regulation of the acid-base equilibrium in the blood, with which respiration was closely connected. This in turn led him directly to a study of methods of resuscitation in cases when, for one reason or another, the

respiratory centre in the brain was showing signs of failure.

An outstanding instance of Henderson's shrewdness in the application of knowledge gained in the laboratory to the solution of practical problems in everyday life is afforded by his work on carbon monoxide poisoning. In severe cases of carbon monoxide poisoning, the best method hitherto advocated for treatment was by inhalation of oxygen; yet this was often disappointing since, as he showed, the respiratory centre had already begun to fail owing to the serious deficiency of oxygen to which it had been subjected because of the displacement of oxygen from the hæmoglobin in the blood by carbon monoxide. By adding 5 per cent or more of carbon dioxide to the oxygen inhaled, he found that the increased stimulus to the respiratory centre antagonized its failure, and with the maintenance of effective breathing the rate of elimination of carbon monoxide from the blood was greatly accelerated and a far better opportunity afforded for the eventual resuscitation of the victim. Oxygen – carbon dioxide inhalation is now universally recognized as the best treatment for carbon monoxide poisoning.

Henderson showed, too, that similar treatment might have a far wider application in clinical medicine when stimulation of the breathing or the maintenance of hyperpnœa might be requisite, for example, in the resuscitation of the new-born baby, in accelerating the elimination of volatile anæsthetics through the lungs after surgical operations, or in improving the breathing and reducing the risk of atelectasis in inflammation of the lungs. He had, however, an uphill fight before his views gained acceptance. Many regarded carbon dioxide as a poison the elimination of which from the lungs ought to be promoted and not hampered, and it took time to bring home the idea that carbon dioxide was also a natural stimulus to the breathing and could rightly be used for this purpose in clinical medicine.

Henderson's wide knowledge of the general physiology of respiration introduced him to many other practical problems. He was associated with the U.S. Bureau of Mines in the design of mine rescue apparatus and in the detailed investigation by which standards of ventilation were fixed for the ventilation of the Holland Tunnels between New York and New Jersey so as to prevent any risk of carbon monoxide poisoning caused by the heavy motor-car traffic. During the War of 1914–18, he worked on the physiological problems of aviation, and, after the start of gas warfare, on the properties of poisonous gases and means for securing protection against them; this led to the publication in 1927, in collaboration with H. W. Haggard, of his well-known book "Noxious Gases", a monograph which was to serve as the basis for the treatise "Schädliche Gase" by Flury and Zernik, which was published in 1931 in Berlin.

Much of Henderson's work is summarized in his book "Adventures in Respiration", published in 1938, and this affords an insight into the way in which his ideas developed and the difficulties that he faced and overcame.

A stout friend and a doughty opponent, Henderson retained throughout his working life the enthusiasm and the vigour of his youth. He had the courage of his convictions and really enjoyed a battle of words and wits, and he could speak bluntly in argument. But whether one agreed or disagreed with him, his views were always worthy of serious consideration. That he made mistakes is no doubt true, for no one is infallible; but there is no question that he played a great part in the development during the present century of our knowledge of the wide field of physiology embraced in the term 'respiration', and in the application of this knowledge to practical problems. It can rightly be claimed that his work on resuscitation has saved many lives that would otherwise have been lost. C. G. DOUGLAS.

Mr. H. H. Brindley

BY the death on February 18 of Harold Hulme Brindley, science lost a great personality. He was born at Highbury on June 17, 1865, the son of the then recorder of Hanley. Educated at Mill Hill School, he entered St. John's College, Cambridge, in 1884. Here he shared in all undergraduate activities, rowing in the boats, lieutenant in the Volunteers, president of the Debating Society, finally taking honours in the Natural Sciences Tripos in 1888. Careless of examinations, he obtained inspiration by aiding Weldon and Bateson in a period which was largely devoted to measurements designed to ascertain the technique of natural selection. An article on variation in the number of joints in the cockroach's tarsus greatly influenced Bateson, for it showed perfection with no intermediates whether there were four or five joints, each a 'normal' form, a 'discontinuous and total variation'. The facts were contested, as in regeneration a four-jointed tarsus is common, but he maintained his position, finding a case of four-jointed tarsi on all six legs. This led him later to a study of regeneration in general, especially in insects and vertebrates. His experiments on the different instars of Lepidoptera were particularly interesting.

Brindley then turned to the earwigs, with their long and short forceps. He scouted the idea that they were distinct species, a view extended to Xylotrupes beetles, two forms each with its fluctuations yet markedly discontinuous. For many years he kept cages of earwigs to experiment on their feeding habits and reactions. He found that their capture of insects by their forcipes in their nocturnal excursions was important, but they could live healthily on purely plant-food, though preferring dead animal matter. Dahlias and roses were mainly of use as hiding places, though their petals were agreeable. For their natural control, birds, except starlings, were unimportant. For proportions of sexes and other enumerations, he collected in the Scilly islands, but we recall with most interest his study of their parasitic infections. Clepsidrina abounded in the hind gut, while gordiid thread worms up to 50 mm. long often destroyed the whole gut; there were also acarine mites and fungoids, but parasitism did not produce any difference in respect to high and low males.

While collecting earwigs all over Cambridgeshire, Brindley also took the molluscs, obtaining more than a hundred species, and he observed that the progressive drainage of three centuries had not resulted in any marked invasion of Wicken Fen by terrestrial forms. Annual excursions to Arcachon were for the purpose of studying the larval processions of the moth, Cnethocampa, these first described by Réaumer. He broke up natural into artificial processions, but the question of direction is still undetermined. Mass attacks for oviposition were continuously made by tachinid flies, countered largely by the urticating properties of the larval hairs. During all these periods, indeed for fifty years, he had charge of the

first M.B. teaching in the Zoological Laboratory at Cambridge, more than five thousand students passing through his hands. He declined preferment, for the low pay of those days made private coaching necessary, while there were then no grants available for his research purposes. He became steward of his College during 1914–23, finally being elected a fellow in 1931.

Meantime Brindley had attained high distinction in other fields. He was a keen member of the Cambridge Cruising Club, and his knowledge of ships was unsurpassed. Hardy (later Sir William) had him and Graham Kerr as crew on his *Raven*, when she was the first yacht to pass westward through the Kiel Canal. He was one of the founders of the Society for Nautical Research in 1911, and he never missed a council meeting for twenty-eight years. He was a prolific writer in its journal, his chief subject the medieval ship. This and a love for St. Christopher led him to many ports and gave play to his artistic abilities, a study of medieval glass giving him great joy. He put his chief trust in engraved seals, and extended his research to every seaport in Europe. He arranged a special room for them in the National Maritime Museum at Greenwich, to which he gave his own unmatched collection. These settled the dates at which the rudder replaced the steering oar and the use of reef points. He was also an authority on primitive sailing craft.

Here was a character with a genius for friendship, equally at home in the discussions of art, literature and science, at first a noted contributor to the advance of biology, later a historian of nautical evolution, always the inimitable and humorous word-painter of the many noted personalities he had met, a real lover of life.

J. STANLEY GARDINER.

NEWS and VIEWS

Prof. A. R. Todd, F.R.S.

PROF. A. R. TODD has been appointed professor of organic chemistry in the University of Cambridge as from September 1944. Prof. Todd received his early education at Allan Glen's School, Glasgow, and passed from there to the University of Glasgow where, after a brilliant academic career, he graduated in 1928 and commenced his first research under the direction of Prof. T. S. Patterson. In October of the following year he went to work with Prof. W. Borsche in the University at Frankfurt-am-Main, where as a Carnegie Research Scholar he studied the chemistry of certain bile acids, and in 1931 presented the results of this work in the form of a thesis for which he was afterwards awarded the degree of Ph.D. On his return to England, he was elected to a Senior Studentship of the Exhibition of 1851 and worked for the next three years in the research laboratory of Sir Robert Robinson at Oxford. For his researches on the synthesis of anthocyanins during this period he was awarded the degree of Ph.D. At the invitation of the late Prof. G. Barger, he moved from Oxford to Edinburgh in 1934 to take up the study of the chemical constitution of vitamin B_1. The skill with which he led his team during this period and finally determined the structure of the vitamin, and of its fluorescent oxidation product, thiochrome, established his reputation as an outstanding organic chemist.

IN 1936 the Governing Body of the Lister Institute invited Dr. Todd to continue his researches in the Biochemical Department, and for the next two years he and his co-workers investigated the nature of the groupings responsible for the characteristic physiological action of vitamin B_1 and completed the synthesis of a number of compounds structurally related to the vitamin. Dr. Todd became a reader in biochemistry in the University of London in 1937. During his stay at the Lister Institute, he continued his researches on the constitution of the anti-sterility vitamin (vitamin E) and engaged in many other topics which included the chemistry of certain anthelmintic drugs and the active principles of *Cannabis indica*. In 1938 Dr. Todd was appointed professor of chemistry and director of the Chemical Laboratories in the University of Manchester, and with the increased facilities available at this famous centre of research, he was able to engage in an ever-widening array of synthetic and constitutional problems. Prof. Todd was elected a fellow of the Royal Society in 1942. Chemists and biochemists throughout the country will wish him every success and happiness in his new appointment.

Royal Commission on Population

IT is announced that the Royal Commission on Population has been constituted as follows: Lord Simon (*chairman*); Prof. A. M. Carr-Saunders, director of the London School of Economics; Sir Hubert Henderson, of the Treasury, formerly joint secretary to the Economic Advisory Council; Prof. A. W. M. Ellis, regius professor of medicine in the University of Oxford; Dr. Ethel Cassie, formerly senior assistant medical officer of health for maternity and child welfare, Birmingham; Lord Cranbrook, deputy regional commissioner for the Eastern Civil Defence Region; Lady Dollan, wife of a former Lord Provost of Glasgow; Mr. R. C. K. Ensor, research fellow of Corpus Christi College, Oxford; Mr. J. R. Hobhouse, of Messrs. Alfred Holt and Co., Ltd., Liverpool; Mrs. Margaret Jay, a member of the L.C.C.; Mrs. Gwen Longmoor, wife of a West Hartlepool factory worker; Mrs. G. P. Hopkin Morris, wife of the B.B.C. regional director for Wales; Lady Ogilvie, wife of the former director-general of the B.B.C.; Mrs. Helen Pawson, area representative for Wales of the W.V.S.; Mr. A. Roberts, general secretary of the Association of Card Blowing and Ring Room Operatives; and Mr. W. Dunkeld Robieson, editor of the *Glasgow Herald*.

Associated with the Royal Commission will be the three following technical committees: *Statistical Committee:* Prof. A. M. Carr Saunders (*chairman*), Mr. V. P. A. Derrick, Dr. D. V. Glass, Mr. R. R. Kuczynski, Mr. J. G. Kyd, Mr. H. Campion, Mr. A. Reeder, Dr. P. Stocks, Mr. F. A. A. Menzler and Mr. G. H. Maddex. *Economics Committee:* Sir Hubert Henderson (*chairman*), Mr. E. C. Ramsbotham, Prof. Alexander Gray, Prof. J. R. Hicks, Mr. W. B. Reddaway, and Mrs. Joan Robinson. *Biological and Medical Committee:* Prof. A. W. M. Ellis (*chairman*), Prof. E. D. Adrian, Prof. D. Baird, Dr. P. H. F. Bishop, Dr. C. P. Blacker, Mr. Eardley L. Holland, Dame Louise McIlroy, Dr. A. S. Parkes, Mr. E. W. Riches,

Sir Alexander Russell, Dr. P. Stocks and Dr. J. G. Thwaites. The secretary of the Royal Commission and of the three committees is Mr. N. F. McNicoll, of the Ministry of Health.

The terms of reference of the Royal Commission are to examine the facts relating to the present population trends in Great Britain; to investigate the causes of these trends and to consider their probable consequences; to consider what measures, if any, should be taken in the national interest to influence the future trend of population; and to make recommendations.

Lavoisier Statue in Paris

ACCORDING to the July 1943 issue of the French monthly philatelic review, *L'Echangiste Universel*, a copy of which has just reached Great Britain, a 4-franc postage stamp is being issued in commemoration of Lavoisier, the centenary of whose birth occurred on August 26, 1943 (see NATURE, Aug. 21, 1943, p. 207). Incidental reference is made to the removal "depuis un an" of the bronze statue of Lavoisier which stood at the north end of the Madeleine, not far from his town house (now rebuilt), 17 Boulevard de la Madeleine. *L'Echangiste Universel* appears to have no doubt about the fate of this superb monument—the work of Barrias—for its removal is attributed, with tactful obliquity, to the "service de la récupération des métaux", and the comment is added: "Pauvre Lavoisier connut à deux réprises, les vicissitudes de l'exécution capitale".

It will be remembered that Barrias adorned the pedestal of this beautiful work of art with two bronze reliefs, one of which depicted Lavoisier at work in his laboratory with Madame Lavoisier, his capable and devoted assistant, who is said to have learnt English so that she might translate for her husband the scientific papers of his great contemporaries, Cavendish and Priestley. In the other panel could be seen Lavoisier lecturing before the Paris Academy of Sciences, with Lagrange, Monge, Lamarck, Condorcet and Laplace among his audience. Though the pedestal was standing when *L'Echangiste Universel* recorded the destruction of the statue, the activities of the "service de la récupération des métaux" in occupied countries would seem to indicate that Barrias' bronze panels, with the statue, may never be seen again.

New Mathematical Tables

THE many users and admirers of the New York Work Projects Administration Mathematical Tables always studied the impressive list at the end of each volume of further tables to be published, and looked forward to the time when much-needed values would be available. It was a great shock to them when President Roosevelt announced, towards the end of 1942, that all W.P.A. activities were to cease; it was hard to realize that such a great international asset as the wonderful New York team of computers—the greatest the world has ever known—was to be destroyed at a time when its proved usefulness might have been diverted to the war effort. Actually, although the greater part has been disbanded, a nucleus has remained in being to help the Service departments, under the sponsorship of the U.S. Bureau of Standards. Naturally there were, early in 1943, a great number of tables ready for press, but not printed. It is with feelings of relief that we learn that the publication of these has now been provided for, and that four volumes have been announced already. The first gives reciprocals of the integers from 100,000 to 200,000, and thus extends the tables of Oakes (now unobtainable) and Cotsworth, which stop at 100,000. The second is a 10-place table of the Bessel functions $J_0(z)$ and $J_1(z)$ for complex arguments, giving real and imaginary parts for $\varphi=0(5°)90°$ and a range 0(0·01)10 of the modulus. The third table gives circular and hyperbolic tangents and cotangents to eight significant figures for $x=0(0\cdot0001)2$; it is thus a companion to the similar values of sines and cosines that appeared in 1939. The American practice of computing by calculating machines led to a revival some fifteen years ago of the Lagrangian interpolation formula. The new tables now provided give the coefficients for interpolating with any number of points (that is, tabular values) from 3 to 11. Incidentally, they include all the coefficients of Everett's central difference formula. The tables are to be issued by the Columbia Press, Ithaca, N.Y. (in Great Britain by Scientific Computing Service, Ltd., 23 Bedford Square, London, W.C.1).

British Medical Bulletin

IN 1940 the Medical Research Council, the Ministry of Information and the editorial department of the British Medical Association decided to send abroad abstracts of important articles in British medical journals, and Dr. Howard Jones was appointed to do this work under the direction of the editor of the *British Medical Journal*. By the end of 1941 a British Medical Information Service had been formed, and the British Council, which had supported the work from its inception, took it over as a permanent part of its work. The *British Medical Bulletin* is published in English, Turkish, Portuguese and Spanish, and Dr. Howard Jones, who is now a whole-time officer of the British Council, has made it a valuable addition to medical literature.

One Hundred Years at the Cincinnati Observatory

EVERETT L. YOWELL has an interesting article with the above title in *Sky and Telescope* (3, No. 2; December 1943). He gives an account of the development of the Observatory from the days when Ormsby MacKnight Mitchel resigned his professorship of mathematics, engineering and mechanics at Cincinnati College, and later, in the spring of 1842, started giving lectures on astronomy. These lectures were so well received that Mitchel announced his intention of building and equipping an observatory; and immediately he solicited membership for a society, each member to subscribe for a share at 25 dollars. It is remarkable that in spite of many initial difficulties—lack of funds in particular—Mitchel began the erection of the building with one carpenter and one mason as foremen, and on November 9, 1842, ex-President John Quincy Adams, then in his seventy-seventh year, laid the corner stone. In January 1845 the 11-inch refractor which Mitchel had purchased in Munich arrived; it was mounted in the spring of the same year.

As the Observatory was without endowment, Mitchel agreed to act as director for ten years without remuneration. Unfortunately, he had to devote a lot of time to lecturing at the College, which provided his only means of livelihood, and in consequence he

had very little time for astronomical work. The Observatory passed through many changes, including its removal to a better site and the appointment of Prof. Ormond Stone as director in 1875. He revived the study of double stars which had been undertaken by Mitchel, but was carried out in a desultory manner owing to other responsibilities. Stone was succeeded by H. C. Wilson (1882–84), Dr. Jermain G. Porter (1884–1930), E. L. Yowell, the author of the article (1930–40), and Dr. Elliott S. Smith, who succeeded him and is now in charge. A catalogue of stars observed by Dr. Smith is nearly ready for publication, and Dr. Paul Herget has done valuable work in computing orbits for the last two satellites of Jupiter.

Penicillin

A SPECIAL issue of the *British Medical Bulletin* (2, No. 1; 1944) devoted to work on penicillin contains special articles by Prof. L. P. Garrod, Prof. A. Fleming, Prof. H. W. Florey, Dr. E. Chain and Dr. M. E. Florey, and reviews of papers published between 1929 and 1943 on the discovery of penicillin and on its chemotherapeutic action, purification and chemical properties and on clinical trials of it. An appendix deals with the Oxford Unit, the slide-cell technique and communications not reviewed in this issue of the *Bulletin* or published in other countries. Everyone interested in penicillin will find this excellent review of the subject valuable.

West Indian Conference

THE first of a regular system of West Indian conferences is to be opened in Barbados on March 21 (see p. 320 of this issue). The conference, which will be presided over by Sir Frank Stockdale, British co-chairman of the Anglo-American Caribbean Commission, will consider means of raising the nutritional level in the Caribbean area, the re-absorption into civil life of persons engaged in war employment, the planning of public works for the improvement of agriculture, education, housing and public health, health protection and quarantine, industrial development, and the Caribbean Research Council and possibilities for its expansion.

Royal Society of Edinburgh : New Fellows

THE following have been elected ordinary fellows of the Royal Society of Edinburgh: Mr. John Anthony, lecturer in botany, University of Edinburgh; Dr. Daulatrai Bhatia, senior lecturer in zoology, Government College, Ludhiana, India; Prof. David Burns, Department of Physiology, University of Durham; Mr. John G. Carr, cancer research worker, Institute of Animal Genetics, University of Edinburgh; Dr. R. W. Craig, Scottish Secretary, British Medical Association; Dr. L. J. Davies, lecturer, Department of Medicine, University of Edinburgh; Prof. E. M. Dunlop, Department of Bacteriology, University of Durham; Mr. J. M. Geoghegan, president of the Society of Accountants in Edinburgh; The Hon. Lord Gibson, chairman of the Scottish Land Court; Mr. J. Methuen Graham, surgeon, Edinburgh Royal Infirmary; Prof. Arthur Holmes, Department of Geology and Mineralogy, University of Edinburgh; Dr. D. J. A. Kerr, lecturer on forensic medicine, School of Medicine of the Royal Colleges, Edinburgh; Prof. J. R. Learmonth, Department of Surgery, University of Edinburgh; Dr. W. Ledermann, assistant lecturer and Carnegie Fellow, University of St. Andrews; Dr. A. D. McEwen, chief bacteriologist, Moredun Institute Animal Diseases Research Association, Midlothian; Dr. Robert McWhirter, lecturer in radiology, University of Edinburgh; Major Noel Ewart Odell, Clare College, Cambridge; Dr. R. F. Ogilvie, lecturer in pathology, University of Edinburgh; Prof. G. D. Preston, Department of Physics, University College, Dundee; Mr. W. S. Procter, regional engineer, Post Office Engineering Branch, Scottish Region; Dr. T. Robertson, district geologist, H.M. Geological Survey, Edinburgh; Dr. R. W. Scarff, reader in morbid anatomy, University of London; Mr. E. Openshaw Taylor, lecturer in electrical power and machinery, Heriot-Watt College, Edinburgh; Dr. O. A. Trowell, lecturer in human physiology, University of Edinburgh; Prof. J. Stirling Young, Department of Pathology, University of Aberdeen.

Announcements

THE triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1943 to the Institution of Electrical Engineers, has been made by the Council to Mr. Harold Page, for his paper on "The Measured Performance of Horizontal Dipole Transmitting Arrays".

THE award for 1943 of the Page Prize for the best thesis submitted in lieu of the Associate Membership Examination of the Institution of Electrical Engineers has been made by the Council to Mr. J. V. Beaumont for his thesis entitled "Types of Power Transformers, with special reference to On-Load Voltage Regulators".

THE Institution of Electrical Engineers will this year make awards of the Duddell and Manville Scholarships. These Scholarships are each worth £150 a year for three years. They are open to British subjects who are less than nineteen years of age on July 1, 1944, who have passed the matriculation examination of a British university, or an equivalent examination, and who wish to take a whole-time day course in electrical engineering. Applications for particulars and nomination forms should be addressed to the Secretary of The Institution, Savoy Place, London, W.C.2. Nomination forms must be returned not later than April 15.

THE ninth Pedler Lecture of the Chemical Society will be delivered by Dr. C. R. Harington on March 16 at 2.30 p.m. Dr. Harington will speak on "Newer Knowledge of the Biochemistry of the Thyroid Gland".

A WEEK-END course for medical practitioners on factory medical services and industrial diseases will be held at the London School of Hygiene and Tropical Medicine on March 25–26. It will be opened by Sir Wilson Jameson, chief medical officer of the Ministry of Health, and lectures will be given on "Tuberculosis and the Industrial Worker", "Industrial Diseases of Coal Miners", "Medical Inspection of Canteens", "Young Persons in Industry", and "The Medical Selection of Factory Personnel". The fee of one guinea for the course should be sent to the Secretary, London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1, not later than Monday, March 20.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Mechanism of Formation of the Fertilization Membrane in the Sea Urchin Egg

THE mechanism of formation of the fertilization membrane in the sea urchin egg has long been a matter of discussion. Runnström, Monné and Broman[1] recently reviewed the essential points in this discussion. They also resumed, on the eggs of *Psammechinus miliaris* and *Echinocardium cordatum*, the study of the birefringence of the membrane first described by Runnström[2].

The membrane presents a double refraction which is negative in the radial direction. No similar birefringence could be observed on the surface of the unfertilized egg. During the elevation of the membrane the birefringence increases until it reaches the normal value (retardation M 12 mμ).

Unfertilized eggs transferred to hypertonic solution (2 ml. sea water + 0·6 ml. 2·5 N sodium chloride) sometimes form a membrane which is more or less granular and the birefringence of which is considerably lower than that of the normal fertilization membranes. The granules in question seem to be identical with the 'cortical granules' of the unfertilized eggs. These granules are formed at the maturation of the egg. They disappear at fertilization, as was observed by Hendee[3], Lindahl[4] and Moser[5]. The cortical granules are easily observed in sections of unfertilized mature eggs fixed with Fleming's solution and stained with hæmatoxylin.

The sperm of sea urchin was frozen, dried *in vacuo* and extracted with methanol. The residue was treated with sea-water at 90° for three minutes. The extract thus obtained[6] (containing 0·5–0·7 mgm. N per ml.) interferes even in considerable dilutions (1 : 200–1 : 300) with the normal membrane formation, without inhibiting the entrance of the sperm and the copulation of the pro-nuclei. The division of the nuclei always proceeds, while the segmentation of the cytoplasm is more or less inhibited.

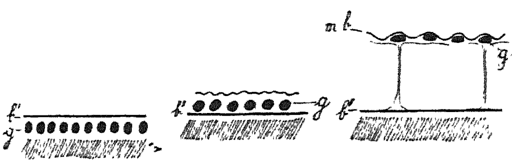
The inhibition of membrane formation occurs in many different degrees (1–4) according to the concentration of the sperm extract. (1) No membrane separates from the egg surface. Even when the eggs are transferred to a hypertonic solution, no membrane becomes visible. Occasionally, however, an elevation of a thin membrane occurs, which is localized at a part of the egg surface.

(2) A membrane is formed, but the perivitelline space of the egg surface is very narrow. In a hypertonic solution, the membrane is seen to be fully separated from the egg surface. The membrane of these eggs is granular and its double refraction is rather low, the retardation amounting only to about half the normal value. Eggs of this kind have been fixed and stained. In eggs with granular membranes no cortical granules are present. The granules of the membrane, however, are stained in the same way as the granules present in the surface of the unfertilized eggs.

(3) The perivitelline space has the normal width. The membrane is somewhat folded or curled, but no granules are visible. The double refraction is not different from that of a normal, smooth membrane. Intermediate stages between (2) and (3) are observed. In these, one part of the membrane may be granular, another part curled, without visible granules. The granules evidently elongate in a tangential direction and enter as an element of the membrane. *The double refraction of the fertilization membrane reaches its normal value only when the granules have been incorporated with the membrane.*

(4) In most diluted solutions of sperm extract a normally raised, smooth membrane may appear. Intermediates exist, however, in which one part of the membrane is curled or even granular, the other being smooth and of perfectly normal appearance.

It seems reasonable to assume that the observations described above under (1)–(4) represent different stages in the normal formation of the fertilization membrane. This view is strongly supported by observations on unfertilized eggs of *Echinocardium cordatum*, which have been transferred to a mixture of 7 parts sea-water and 1 part rabbit or sheep serum. In this mixture perfectly smooth membranes are formed, but the process gradually passes through the four stages described above. Only after about fifteen minutes from the beginning of the process are the normal smooth membranes formed.



(1) (2) (3)

These and a number of further observations give a fairly precise picture of the formation of the fertilization membrane. The first step of the membrane formation may be illustrated by the accompanying schematic diagrams. In (1), representing the conditions before the activation, the cortical granules (g) are situated below the limiting border (b') of the egg. This border is characterized optically by its refringence. With dark-ground illumination, the border is seen to have a yellow-orange colour. The activation involves a reorganization of the peripheral part of the cortex. The border retracts, leaving outside itself a rim of hyaline substance in which the radially, somewhat elongated, cortical granules are found (cf. 2). Simultaneously with this retraction the orange colour of the border changes to a bluish-white, as observed with dark-ground illumination[1,2]. The state represented by (2) could be well recognized in Echinocardium eggs. The rim still adheres to the limiting border (b'') and is not separated from this when the eggs are immersed in hypertonic sea-water.

At fertilization, the retraction starts from the entrance point of the sperm cell and thence spreads over the egg surface in a wave-like manner, as described by Just[7]. About ten minutes after fertilization, the hyaline layer becomes visible on the surface of the normal egg. It is obvious that the formation of the hyaline rim of (2) and that of the hyaline layer are quite analogous processes, the mechanism of which may also be similar.

The step following that of (2) is represented by (3). The membrane is delaminated from the surface border of the cortex and raised under the action of osmotic forces. In the eggs of Echinocardium submitted to treatment with sea-water – serum mixture, even the raised membrane very often still adheres to the border of the cortex by means of more or less developed strands which may later disintegrate.

Such strands are schematically represented in (3). The further development of the granular membrane needs no comment in addition to the above description.

The so-called vitelline membrane of the unfertilized egg is not identical, as often assumed, with the fertilization membrane. It forms only a part of the latter. In certain circumstances, the cortical granules are not incorporated into the membrane. Under these conditions, a thin membrane results which has a low double refraction and may be identical with the vitelline membrane.

The description given above of the fate of the cortical granules is at variance with the ideas entertained by Moser[5] concerning their role in the activation.

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[1] Runnström, J., Monné, L., and Broman, L., *Arkiv f. Zoologi* (Stockholm), **35**, A, Nr. 3 (1943).
[2] Runnström, J., *Protoplasma*, **4**, 388 (1928).
[3] Hendee, Ester C., Papers from Tortugas Lab., Carnegie Inst. Pub., **27**, 101 (1931).
[4] Lindahl, P. E., *Protoplasma*, **16**, 378 (1932).
[5] Moser, F., *J. Exp. Zool.*, **80**, 423 and 442 (1939).
[6] Cf. Runnström, Tiselius and Lindvall, NATURE, **153**, 285 (1944).
[7] Just, E. E., *Biol. Bull.*, **36**, 1 (1939).

Water Contents of Last-stage Larvæ, Pupæ, and Adults of the Meal Moth

ACCORDING to Speicher[1], larvæ and pupæ of the meal moth, *Ephestia kuehniella* Zeller, an important pest in meal stores, maintain a constant percentage of free water, independent of the relative humidity of the environment.

In contrast to Speicher's results, our observations show that migrating larvæ of Ephestia, which have been reared at low relative humidities, have a much lower average water content than larvæ kept at high humidities, although the water contents show considerable fluctuation.

On the other hand, water contents of pupæ of all ages show a practically steady average figure, which is independent of the relative humidity in which the insects were reared. This figure (see accompanying table), which agrees very well with Speicher's value, lies between the average percentage water contents of larvæ reared at 30 per cent and 70 per cent relative humidity respectively.

	Average water content as % of body weight	
	30% relative humidity	70% relative humidity
Migrating larvæ	57·3	73·5
Pupæ	65·4	66·4
Adults	65·4	66·3

The average water content of adults is practically the same as that of pupæ, and again appears to be independent of the humidity of the environment.

It is generally held that the water content in various instars of insect development can be regulated by the retention of metabolic water[2]. It seems, however, that Ephestia larvæ cannot compensate entirely for the increased rate of evaporation of water at low relative humidities.

When larvæ reared at low relative humidities are preparing to pupate, a more efficient mechanism of regulation comes into operation, so that the water contents of the resulting pupæ are almost identical with those reared at high humidities. The average weight of these pupæ developing at low humidities (30 per cent relative humidity), however, is approximately only 80 per cent of those reared under standard conditions (70 per cent relative humidity). It may be that the regulatory process involves the oxidation of a greater weight of reserve substances during the prepupal stage of those individuals reared in the drier environment.

Low environmental humidity definitely increases the duration of larval development (fifty days at 30 per cent relative humidity, as compared with thirty-three days at 70 per cent relative humidity), but the length of the pupal instar is only slightly affected.

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[1] *Proc. Pennsylvania Acad. Sci.*, **5**, 79 (1931).
[2] Wigglesworth, V. B., "Principles of Insect Physiology", 354 (London, 1939).

New Interference Phenomena with Newton's Rings

SOME striking new interference phenomena have been found with Newton's rings by using multiple-beam interference instead of the usual two beams. The rings, formed between a convex lens and a flat piece of glass, are modified profoundly by the employment of multiple beams. The two surfaces in contact are coated (by evaporation *in vacuo*) with high reflecting coefficient transparent silverings, the reflecting coefficient exceeding 0·85 for the green mercury line. The resulting multiple beams lead to the production of fringes which are characterized by their remarkable sharpness. The fringes in transmission are fine narrow brilliant rings on a broad dark background, and in reflexion can be seen a complementary system of fine dark 'absorption' fringes on a broad bright background.

Normal Incidence. Typical transmission rings (green mercury) with light incident normally on the interference faces are shown in Fig. 1. The sharpness is unique. It is necessary to restrict the incident light to a single angle of incidence by employing a small source at the focus of a lens in order to achieve the best definition. Comparison with the ordinary classical two-beam rings reveals the superiority of the multiple-beam fringes in the following particulars:

(1) They are much more intense.

(2) They are so sharp that very high precision can be attained. A change of 1/100 of an order can readily be *accurately* measured. This corresponds to a displacement of only 25 angstroms between the optical components. A great increase in precision is thus now available in all the numerous metrological applications of Newton's rings.

(3) The fringes are so inherently sharp that fine-scale surface defects and irregularities on the glass surfaces are rendered as detail in the fringes. For the reproduction shown as Fig. 1, the flat component was a simple piece of glass, and all the local

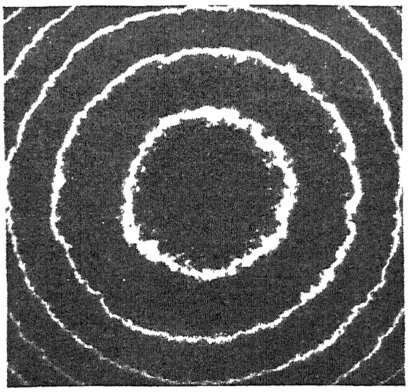


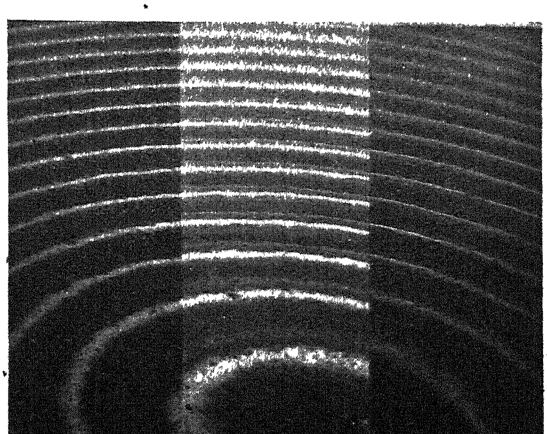
Fig. 1. Newton's rings with multiple beam interference.

irregularities are clearly shown by the irregularities of fringes.

(4) By matching the curved component against a high-grade optical flat, the perfection of figure of the lens surface is revealed, with very great sensitivity. This effectively extends to curved surfaces the existing multiple-beam Fizeau test, used to-day only for flat surfaces.

Non-normal Incidence. New interference phenomena appear when the angle of incidence is other than normal. The fringes are no longer located in the film but lie on focal curves, one half of the ring system being situated before and the other half behind the interference film.

The fringes become double; the separation between the two components growing steadily with increasing incidence. One component moves *out* towards the next higher order, becoming progressively *weaker* and also *sharper*. These two components are plane polarized, mutually perpendicularly. The phenomena are shown clearly by Fig. 2, which refers to an incidence of 60°. Fig. 2*b* shows the doubling, with no Nicol prism in the beam. In Fig. 2*a* a Nicol has been interposed to pass the beam with the magnetic vector perpendicular to the plane of incidence; and in Fig. 2*c* the Nicol has been set to pass the parallel component. Owing to the peculiar focal properties of the non-normal fringes, only the fifth and sixth fringes are in focus in this reproduction.



a b c

Fig. 2. Doubling due to differential phase change at reflexion. (*a*) Magnetic vector perpendicular to plane of incidence; (*b*) no Nicol prism; (*c*) magnetic vector parallel to plane of incidence.

The cause of the doubling is the existence of a differential phase change at reflexion at the silver surfaces. The phase change is different for the mutually perpendicular directions of vibration of the light. This differential effect has been measured over the range of incidence 0–80°. To the first order, the observations closely confirm the predictions of classical electromagnetic theory. Up to an incidence of 60° the experimental curve runs closely parallel to the theoretical curve, but is displaced upwards by a quite small, but real, amount, 0·007 λ. The observations reveal a marked, but small, inflexion at 63°, not predicted by theory, which is probably incomplete as to finer detail.

The remarkable sharpness of the parallel vector (see fifth and sixth fringes) is due to the higher effective Fresnel reflecting coefficient for this vector. It can be demonstrated that this parallel vector is rapidly absorbed with increasing incidence, and the rate has been determined. It follows from this that an evaporated silver film, when used to transmit light incident at high angles of incidence, should act as a polarizer (partial) in a manner similar to that which makes tourmaline act as a polarizer by differential absorption. This interesting property has been shown to exist, and can be very easily demonstrated.

The same characteristic fringe-doubling due to the differential phase change at reflexion at the silver has been found with small-gap Fabry-Perot interferometers, with the necessary modification that the parallel vector moves *inwards*, to the region of higher order of interference. For gaps of less than 1 mm., the differential doubling can lead to an appreciable loss in resolution, if the incident light is not polarized to compensate for this.

Full experimental details, together with an analysis of the phenomena very briefly surveyed here, have been communicated elsewhere.

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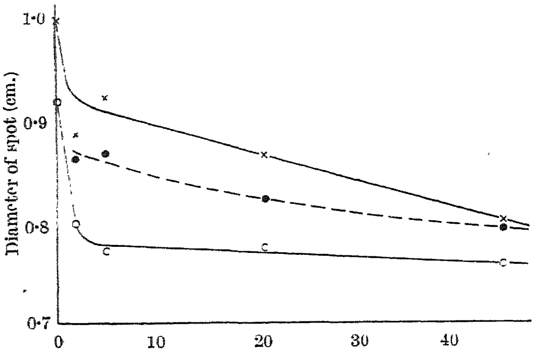
Jan. 29.

Influence of an Adsorbed (Inner) Layer on the Cohesion of a Solid

In Nature of January 22, Benedicks and Sederholm, under the above title, showed that the exposure to air of freshly cut surfaces of paraffin, lead and tin resulted in a lessened cohesion when two plane surfaces of the solid in question are brought into contact. By measuring the cohesion after different periods of exposure to the air, it was shown that, in the case of tin for example, important changes took place during the first five minutes exposure of a freshly cut surface. These changes are attributed to the rapid formation of a thin adsorbed layer.

A similar effect has been observed with silver and with iron by another simple technique. When a drop of distilled water of volume 0·03 c.c. is allowed to fall a distance of 2 cm. from the jet of a burette on to a freshly cut surface of the metal fixed in a horizontal position, the diameter to which the drop spreads before coming to rest is governed to a certain extent by the length of time the metal surface has been exposed to air.



Curve I, ×; Curve II, ●; Curve III, ○.

The effect of exposing freshly cut silver (Curve III) and freshly cut iron (Curve I) to air inside a desiccator containing calcium chloride is illustrated in the accompanying graph, which also shows (Curve II) that the air of the laboratory in which these experiments were carried out does not affect the freshly cut silver in the same manner as does the drier and purer air inside the desiccator. In these experiments the surfaces were freshly cut by means of the unused emery face of a piece of Hubert emery paper grade 1*M*, any residual emery powder being quickly rubbed off by a few strokes with a ball of dry cotton-wool.

The importance of the pre-exposure of a metal surface to air in connexion with its chemical behaviour was established some years ago by U. R. Evans[1].

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[1] Evans, U. R., "Metallic Corrosion Passivity and Protection".

Determination of Specific Heat of Metals

I HAVE recently discovered a simple and novel method for measuring the specific heat of metals having known temperature-resistance coefficients.

A current, of sufficient magnitude to heat a wire to its melting temperature in a short time (within, say, 5×10^{-2} sec.), is passed through the wire. Under these conditions, the losses from the wire are negligible. By recording oscillographically the current through, and potential across, the wire, one can determine at any instant the resistance of the wire, from which its temperature can be found, and the energy imparted to it. From a single test one can thus draw a curve connecting energy input with temperature rise, from which one can determine the specific heat at any temperature within the range of the test or the mean specific heat over any range of temperature.

Fuller details, together with test results, will be given in an E.R.A. report shortly.

The method might be applied to any electrical conductor the resistance of which varies with temperature, the temperature coefficient being known.

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Dipole Moments of Polyatomic Molecules

IN calculating the dipole moments of polyatomic molecules, it is assumed that the observed moment is vectorially composed of the moments of the various links or bonds. The bond moments so deduced have no simple relationship to the values calculated from the internuclear distances and the electronic charge. The valency angles calculated from them vary and do not agree with theoretical values or even those found by other methods; interactions of the bond moments have been postulated in order to produce agreement between the calculated and the observed values. There is no vector between the bonds connected by single links due to free rotation or uncoupling.

These and other difficulties in the interpretation of dipole moments of polyatomic compounds are simplified by the conception that the dipole action is due to the rotation of the needle-shaped dipole[1], and each bond affects the polarization with the components of the other bonds calculated along the connecting links. The moments of the bonds are uncoupled when connected by single links. In the case of rigid molecules, the bond moments are affected inductively by the components along the connecting links and then add up vectorially.

Thus, according to vectorial addition, the observed moment in a triatomic molecule *ABA* is (I) $R = m^2 + m^2 + 2mm \cos \theta$, where m is the *AB* bond moment and θ is the *ABA* angle and the molecule is polarized along *BR*, where the angle *ABR* is $\theta/2$. According to the new law, (II) $R = m + m \cos \theta$, and the direction is along each *BA*.

When the dipoles are separated by a single connecting link with the same angle, the observed moment according to the new law is (III) $R = m + m \cos \theta^2$. If one more additional link making the same angle is introduced, the resultant is $m + m \cos \theta^3$. If the link bonds have their own moments, the respective components have to be added, paying regard to the sign. When the two end bonds are dissimilar, the resultant is represented by the arithmetic mean of the values calculated in the direction of each bond, or by the rule of squares.

In water the bond moment OH is $\frac{1}{2}$ ionic or dipolar ($2 \cdot 5D$), which, using 105° as HOH angle, gives $1 \cdot 88$ as the dipole moment of the H_2O molecule (obs. $1 \cdot 87D$). The calculated value for hydrogen peroxide assuming the tetrahedral angle for H–O–O is $2 \cdot 22D$ (obs. 2·14). The C–O bond is $\frac{1}{2}$ ionic ($3 \cdot 5D$) in alcohols and acids and $\frac{1}{4}$ ionic ($1 \cdot 75D$) in ethers, which leads to $1 \cdot 68D$ for the dipole moment of all alcohols and 1·13 for all ethers. The dipole moments of substituted anisoles are also in full agreement with the calculated values. The C=O bond is $\frac{1}{2}$ ionic and the calculated bond moment 2·98 is observed in all ketones. The calculated dipole moment of acetic acid is $1 \cdot 76D$ (obs. $1 \cdot 71D$). The uncoupling of C=O and OH bonds takes place owing to free rotation along the link C–O. The dipole moment of ethylene dichloride is $1 \cdot 69 \times (1 - \cos \theta^2) = 1 \cdot 50D$ (obs. $1 \cdot 5D$ at 200°); of quinol dimethyl ether using COC angle 105°, found in dimethylether, is $1 \cdot 75 (1 - \cos 75^{\circ 2}) = 1 \cdot 64D$ (obs. $1 \cdot 67D$).

The law of component moments accounts quantitatively for the anomaly of flexible molecules, the ortho, meta, para moments in aromatic compounds, the substituted anisoles, the diphenyls and naphthalenes, etc., on the basis of the regular geometry of the

molecules and theoretical values of angles and bond moments. Details will be published elsewhere.

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[1] NATURE, 153, 222 (1944).

Solubilization of Dyes in Non-aqueous Solvents

THOUGH a large number of instances of solubilization of water-insoluble substances like dyes, hydrocarbons, etc., in aqueous solutions of detergents are known[1], very few definite cases of the same phenomena have been reported for non-aqueous systems. In a recent note, McBain[2], for the first time, has adduced qualitative evidence to show the existence of such solubilization by hydrocarbon-soluble soaps and detergents, and has very recently cited a few more instances[3].

I have, however, observed that such solubilization is of rather frequent occurrence in the behaviour of resins dissolved in non-aqueous solvents. A systematic study has been undertaken and the results will be reported later. The present note records the hitherto unnoticed strong solubilizing power of resins, and also to direct attention to some peculiarities in this process not noticed by McBain and co-workers[2]. Their "experimental procedure has been to take approximately 1% solutions of pure or commercial detergents as supplied by the makers and add solid dye. Solubilization is indicated by the almost immediate coloration of the liquid." There is, however, an underlying source of error in this process of indicating solubilization, owing to the fact that some dyes ordinarily regarded as insoluble dissolve in traces in hydrocarbons to give a colourless solution which develops colour in presence of the dissolved resin (solubilizer). A good example is rhodamine; this dissolves slightly in benzene or toluene to give a colourless solution, which becomes pink on dissolving even a fraction of one per cent resin in it. So it is always necessary to check against such 'false' solubilization by noting the effect of adding the solubilizer to the dye-saturated solvent. This and other peculiar cases of chromatic interactions between dyes and resins have been observed and are receiving closer study.

A few cases of true solubilization are now being reported. The resins used have been crystalline abietic acid (the chief constituent of American rosin), purified glycerol triabietate (the chief constituent of ester gum) and soft resin of shellac, in 0·5 per cent solution in toluene and benzene at room temperature. Increase of temperature has always been found to favour solubilization. So far, about fifty pure and commercial dyes have been tried, of which only about ten have shown true solubilization to a more or less extent as given in the following list, cases marked with an asterisk indicating a very strong effect: Ester gum solubilizes methyl violet*, phenoplastic blue *RB**, methylene blue, brilliant green, alkali blue, quinoline *A*, safranine, neutral violet and phenoplastic yellow *6G*; abietic acid solubilizes monalite red *2RS*, brilliant green, alkali blue and quinoline *A*; soft resin of shellac solubilizes methyl violet*, phenoplastic blue *RB** and brilliant green.

McBain[2] believes that non-aqueous solubilization, like its aqueous counterpart, is due to adsorption of the dyes on the micelles. We, however, find in this phenomena a manifestation of the already observed liquid-like behaviour of resins[4], which might perhaps be ultimately due to the strong association tendency of the resin molecules, leading to formation of association dimers and polymers with the dye molecules.

A detailed examination of the mechanism of the process is, however, postponed until more data are forthcoming.

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Dec. 14, 1942.
(Delayed in transit)

[1] Pickering, *J. Chem. Soc.*, 3, 86 (1917). Lester Smith, *J. Phys. Chem.*, 36, 1401, 1672, 2455 (1932). Hartley, "Wetting and Detergency", 153 (1937). McBain and Woo, *J. Amer. Chem. Soc.*, 60, 223 (1938), etc.
[2] McBain, Merrill and Vinograd, *J. Amer. Chem. Soc.*, 62, 2880 (1940).
[3] McBain and Merrill, *Ind. Eng. Chem.*, 34, 915 (1942).
[4] Palit, *J. Ind. Chem. Soc.*, 19, 253 (1942).

Reported Asymmetric Synthesis of Santonin

SOME time ago[1] Paranjape, Phalnikar, Bhide and Nargund reported a synthesis of santonin from optically inactive materials: they now[2] claim that their product was active, being almost entirely the natural (*l*-) isomer. They state that the activity originated in the methylation of a 2-formyl*cyclo*hexanone derivative, and that the crude methylation product from 2-formyl*cyclo*hexanone (I) itself had the large specific rotation of $-26 \cdot 2°$ in chloroform. Although they did not isolate 2-methyl-2-formyl*cyclo*hexanone (II), they claim that an optically active derivative was prepared in a state of purity.

Such an asymmetric synthesis from inactive materials violates no fundamental law and might theoretically be expected to occur once in about $(10^{10})^{20}$ trials.

Nevertheless, Paranjape *et al.* claim to have achieved the asymmetric synthesis repeatedly. As we were interested in the products for another reason, it seemed worth while to repeat one of these experiments.

Sen and Mondal[3] prepared (II), though not in a pure condition, and established its structure by hydrolysis to 2-methyl*cyclo*hexanone. We find that (II) may readily be purified by fractionation at low pressure, forming a colourless oil of camphoraceous odour, b.p. 47°/0·05 mm., n_D^{18} 1·4683 (Found: C, 68·2, 68·4; H, 8·6, 8·4. $C_8H_{12}O_2$ requires C, 68·6; H, 8·6 per cent); the hydrolysis to methyl*cyclo*hexanone was confirmed. Neither the crude methylation product from (I) nor pure (II) showed any optical activity whatsoever.

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M. J. S. DEWAR.
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[1] *Current Science*, 12, 150 (1943).
[2] NATURE, 153, 141 (1944).
[3] *J. Ind. Chem. Soc.*, 5, 609 (1928).

RESEARCH ITEMS

Duration of Immunization against Diphtheria

H. Lyndhurst Duke and W. B. Stott (*Brit. Med. J.*, 710; Dec. 4, 1943) have published a paper of interest to all who have followed the Ministry of Health's advice that children—and especially children under five—should be immunized against diphtheria. They have studied the duration of artificial immunity to diphtheria in the Cuckfield and Burgess Hill areas, which have a child population of 9,600 children aged 1–15 years, 95 per cent of whom have been immunized as a result of a campaign started in 1936 by Dr. Stott. A large number of children under five were immunized. Material was therefore available for the study of the duration of the immunity, and more than 3,000 children were tested by the Schick test 2–6 years after immunization. The authors found that the number of children who lost their immunity rose steadily as time went on; after two years 4 per cent, and after six years 18 per cent had lost it. They conclude that it is important to test children some two years after the completion of the immunization. Boys and girls differ little in their response to the antigen. In great cities some 50–70 per cent of children may become naturally negative to the Schick test, but in rural areas natural Schick-negatives may be few, and in the area studied there was no evidence among children under five that such natural immunization had developed. Discussing the question of diphtheria carriers, the authors state their view that, year by year, as the campaign for immunization against diphtheria goes on, a large body of potential carriers is being formed, and that this has probably already built up the natural or artificially acquired level of immunity and acts as a buffer against large-scale introduction of new sources of the infection. It is important to remember that artificial immunization protects against the toxin which causes the symptoms, but not against the bacillus.

Gut of Nebaliacea

A COMPARISON of the structure of the gut of three species of the Nebaliacea, *Nebalia bipes* (Fabricius), *Nebaliella extrema* (f. Thiele) and *Nebaliopsis typica* (Sars) brings out some significant facts. Miss H. G. Q. Rowett (Discovery Reports, 23, 1–18; Cambridge: at the University Press, 1943; 3*s*. net) has subjected these to a searching inquiry and shows how well adapted each one is to its mode of feeding. Nebaliella and Nebaliopsis were obtained from the "Discovery" collections and are compared with *Nebalia bipes* from British shores. *Nebalia bipes*, the common British shore-living species, has been studied alive as well as in sections. It is a filter feeder, as Cannon (1927) has already shown. Its feeding mechanisms enable it to deal with larger particles as well as with the usual incoming flow of small matter in the zone. While *Nebalia bipes* lives usually above the mud just beneath or among pieces of seaweed, shells and stones, *Nebaliella extrema*, also a mud-dweller, is more a true burrower and feeds indiscriminately on the mud. Owing to the lower value of the food, the gut is adapted to deal more rapidly with much food. *Nebaliopsis typica* is specially interesting, for its gut is much specialized. Living at great depths in the open ocean, its surroundings are very different from the other species studied. There is good reason to believe that it feeds on eggs. A large digestive sac has been developed as a store chamber, meals probably fluctuating in abundance, and the lumen of the intestine has been reduced to ensure that nothing escapes thorough digestion. The fore gut is adapted to the puncturing and sucking of the eggs, and the mandibles to holding them in position during these processes. In this connexion it is interesting that the adaptations of the gut are very similar to those of the nudibranch *Calma glaucoides* of British coasts, which feeds on the eggs and embryos of small shore fishes. Special attention has been given to the musculature of the gut in all three forms. The plan is simple and constant, the changes being chiefly associated with the structure of the chitinous parts, and these in turn may be correlated with the habits of the species. The work is carefully illustrated with well executed text-figures.

Classification of Lamellibranchiata

BASED on a study of the ciliary mechanisms of the gills of the Lamellibranchiata, Daphne Atkins proposed a classification of the group. One of the divisions was termed the Microciliobranchia, and the author has now continued her investigations into the musculature of the gills of this section of the Lamellibranchs (*Quart. J. Micro. Sci.*, 84; 1943). The gill muscles serve several purposes; slight contraction removes obnoxious particles and opens and closes the grooves; more violent contraction not only reduces the size of the gills but also obliterates the interfilamentar and interlamellar spaces, and so reduces the possibility of injury to these delicate structures when the valves are violently closed. The major muscles of the gill axes are arranged in two groups, longitudinal and transverse. The former are in two sets, but as both are inserted into the shell they are able to act as retractors of the gills. The transverse muscles are also in two sets, one above and one below the chitinous support above the axial food groove, and by their action separate or bring together the demibranchs. In addition to these axial muscles there are also series in the demibranchs themselves.

Photoperiodism in the Potato

THE Imperial Bureau of Plant Breeding and Genetics at Cambridge has recently issued a technical communication by C. M. Driver and J. G. Hawkes on "Photoperiodism in the Potato" (Pp. 36. 2*s*. 6*d*.). In Part 1 of the bulletin, C. M. Driver reviews the experimental methods of a number of workers since Garner and Allard's classical investigations in 1920. A discussion then follows on the effect of long- and short-day periods upon vegetative growth, flowering and seed production, stolon and tuber formation and maturity. Potatoes differ in their response to day-length and it is evidently an inherited factor. Some South American species do not form tubers under long-day conditions, while others form them equally well under a range of photoperiods. Temperature has a modifying effect upon the response of the plants to length of day, a high temperature generally being antagonistic to tuber production, while a very low temperature may encourage varieties to form tubers under longer photoperiods than usual. Part 2, by J. G. Hawkes, describes experimental work carried out at Cambridge on the reaction to long and short days of a number of South American potatoes obtained from the Empire Collection. Some 75 clones from eight species were tested and assessed on tuber weight, tuber number, stolon production, time of maturing, height of plants, and flowering. It seems

that flowering in the potato may be dependent on the quantity of light received rather than on the actual length of day, and it is tentatively suggested that the photoperiodic mechanism may apply only to the dominant method of reproduction—in this case, to tuber formation.

Inheritance of a Mutation in Wheat Rust

T. Johnson and Margaret Newton have described the mode of inheritance of a mutant in *Puccinia graminis Tritici* Eriks. and Henn. (*Canad. J. Res.*, 21, C 205; 1943). The mutant is characterized by the production of white pustules on barberry owing to marked destruction of the chlorophyll in the infected area. The inheritance of this is independent of sex or physiological race. The original isolate produced approximately equal numbers of white and normal pustules, and crosses with other races showed that diploidization of the mycelium of normal pustules with spermatia from white pustules initiated races that also produced approximately equal numbers of white and normal pustules. Normal × normal crosses produced normal pustules, whereas white × white were sterile. Uredospores arose only occasionally in white pustules and then by diploidization by spermatia or mycelium from normal pustules.

Meiosis in the Striped Hamster

G. PONTECORVO (*Proc. Roy. Soc. Edin.*, 62, 32; 1943) has compared the meiotic behaviour of the striped hamster with that of the golden hamster previously examined by Koller. The striped hamster has $2n = 24$ chromosomes, a remarkably low number among Mammalia. During mitosis the heteromorphic sex chromosome pair can be distinguished easily since the differential segment is apparent; in the golden hamster, that cannot be found during mitosis. During mitosis, nucleoli are to be found in the striped hamster, but the golden hamster has none. These and other facts suggest that the nucleic acid metabolism is lower in the golden than in the striped hamster. The author makes the interesting suggestion that euchromatin and heterochromatin are similar in containing genes, but that the genes of the euchromatin are specifically distinct from one another and therefore metabolize nucleic acid at different rates. The heterochromatin, on the other hand, contains genes which are closely similar to one another or even replications. One block of heterochromatin may contain different genes from any other block. Hence the nucleic acid cycle is specific for this block. Further, the absence of many sex-linked genes in Mammalia, ever-sporting characters in Drosophila, the rarity of recognizable genes in heterochromatin in an evolution of the sex chromosome, could all be related to this hypothesis.

Transmission-Line Problems and the Impedance Circle Diagram

Willis Jackson and L. G. H. Huxley, in a paper read recently in London before the Institution of Electrical Engineers, point out that in modern micro-wave technique, transmission lines find wide application both for the interconnexion of component pieces of equipment, such as oscillators and receivers and aerial systems, and as inductive and capacitive circuit elements within these pieces of equipment. In the former they are normally several wave-lengths long, but in the latter only fractions of a wave-length. The analysis of their behaviour has been greatly facilitated by the development of a circle diagram technique, the theory and application of which are discussed. This is followed by a discussion of the fundamental principles underlying the transmission-line equations on which this technique is based, and of the meaning to be attached to the word 'impedance' at very high frequencies in respect of terminating attachments to lengths of transmission line. In particular, attention is given to the physical possibility of producing a non-reflecting termination, on one aspect of which there appears to have been widespread misunderstanding.

Variation of Latitude at Greenwich, 1936–40

SIR HAROLD S. JONES, the Astronomer Royal, has communicated a paper (*Mon. Not. Roy. Astro. Soc.*, 103, 5; 1943) on this subject, which discusses the results obtained with the Cookson floating zenith telescope, Royal Observatory, Greenwich, since the introduction of the new programme in 1936. In that year the instrument was moved from the courtyard of the Royal Observatory to the Christie Enclosure, and the new programme consisted of twenty-four groups of pairs of stars, each group extending over about one hour of R.A. Three groups are observed nightly, centred at Greenwich mean midnight, and hence each group can be directly connected with groups on either side of it, differing by 2^h R.A. at the most. Observations were interrupted in the autumn of 1940, and in addition, slight damage to the instrument necessitated dismantling and storing the objective and telescope. The available material up to the autumn of 1940 has been used to determine the variation of latitude over the four years 1936–40. The group corrections, to be added to observed-tabular Z.D. north, are given, and these are in close agreement with those derived by Hulme for the years 1936–38. They contain the periodic term in R.A. $+ 0{\cdot}118'' \sin \alpha + 0{\cdot}012'' \cos \alpha$. Values of the latitude variation, applicable to N.P.D.s, are given for each of the years 1936–40 inclusive.

Interstellar Calcium Clouds

REMARKABLE spectrograms showing complicated structure in the interstellar calcium lines H and K have recently been published (*Astrophys. J.*, 97, 105; 1943). The spectra of fifty early-type stars have been studied with high dispersion (2·9 A./mm.) at the coudé focus of the 100-in. telescope at Mt. Wilson. More than 80 per cent of the stars show complex lines with up to five components. Various regions of the sky show different complexities of structure: towards Perseus and Scorpius single lines are frequent, with at most one satellite; whereas in the Orion, Sagittarius, Cygnus and Lacerta regions intricate structures are the rule. Stars close together in the sky exhibit lines of much the same structure. The evidence strongly suggests that interstellar calcium occurs to a great extent in discrete clouds, each with its own small peculiar motion but with little internal turbulence. Many of the spectrograms show also the additional narrow interstellar lines, atomic and molecular, discovered in recent years. Lines of Fe I seem to occur only in regions showing H and K strongly, whereas the diatomic molecules CN, CH and CH^+ may appear where calcium is not particularly abundant. The wave-length shifts given by these other lines show that they originate in one or other of the calcium clouds producing the H and K lines.

ANGLO-AMERICAN COLLABORATION IN THE CARIBBEAN REGION

THE report of the Anglo-American Caribbean Commission to the Governments of the United States and Great Britain for the years 1942–43, which has now been published*, leaves no room for doubt as to the successful start of this first attempt by Britain and the United States at joint control, and at the same time puts into a proper perspective that excessive concern regarding national sovereignty displayed in the statement issued in Washington with the joint communiqué announcing the creation of the Commission. The report itself is in three chapters, discussing in succession the organization of the Commission and the immediate and the long-term aspects of the Commission's programme, but is supported by the text of the joint communiqué of March 9, 1942, reports of the four meetings of the Commission of the Supply Officers' Conference, Jamaica, May 15–18, 1942, and of the Nutrition, Agriculture, Fisheries and Forestry Meeting in August 1943, which led to the creation of the Caribbean Research Council as an advisory body to the Commission. The objectives of this Council will be to survey needs, determine what research has been done, arrange for dissemination and exchange of the results of research, provide for conferences between research workers or extension workers, and make recommendations for further research and co-operation.

The organization thus far established consists of three interrelated units. First is the Commission itself, consisting of two sections of three members each, appointed by their respective Governments, and charged with the duty of helping the territories and colonies in the Caribbean in charting a system of co-operation which will reinforce their economy and society and give them added strength. The British section is closely affiliated with the Colonial Office in London, and with the Development and Welfare Organization in the West Indies. Second is the Caribbean Research Council, which provides the technical and scientific advice required to promote scientific, technical, social and economic advance, and is itself assisted by sectional committees, the first of which covers nutrition, agriculture, fisheries and forestry. The third unit of the organization is a regular system of West Indian Conferences, which is being inaugurated to provide for local consultation. This unit will be a standing body, meeting as and when required, with two delegates from each territory or group in the Caribbean area.

Following a series of meetings of the Commission and conferences in the West Indies, Washington and London, basic policies have been agreed upon in principle by an exchange of notes between the two Governments. The view is taken that the economic problems of the Caribbean should be regarded as regional rather than local. Generally speaking, a single-crop economy in the West Indies is undesirable. Mixed farming and animal husbandry should be encouraged everywhere, but a closed economic system should not be constituted. Inter-island trade should be encouraged throughout the entire Caribbean region. Advantage should be taken of fishing grounds in, and adjacent to, the Caribbean, and local fisheries with facilities for storage and distribution should be developed and organized. A greater vocational bias should be introduced into the educational system, and in addition to wide improvement of housing and sanitary conditions and an extensive school building programme, the inadequate transport to and within the Caribbean requires improvement. This will need co-ordination and planning on a broad scale. As an immediate and effective approach to the nutrition problem the Commission will investigate the provision of midday meals for children at school. The possibilities of industrial development, though limited, should not be overlooked.

On the immediate aspects of the Commission's programme, the report refers to the action taken to meet the food crisis which developed in the Caribbean in 1942. The Commission was responsible for establishing an organization for the bulk purchase of imported food necessities and assisted in developing a system of inter-island distribution. The measures taken led to a substantial increase in local food production and also to an alteration in the established eating habits of the peoples of the area. The fishery industries have received special attention, and the United States section of the Commission made a study of the sugar situation at the end of the summer of 1942 and formulated proposals which have been taken into account by the United States and the British Government in determining their policy with regard to the 1943 crop.

One outcome of the Conference of Supply Officers was the establishment of an Emergency Land Water Highway to provide a safe transport service from the mainland of the United States to Puerto Rico; in view of the improved situation with regard to submarine warfare, the service over the Hispaniole Highway and the maintenance of stockpiles were suspended in August 1943. The Conference also approved a recommendation that a single supply organization should be created for all the British Colonies, and the British Colonies Supply Mission has been established in Washington.

The long-range aspects of the Commission's programme demand long-term planning, and the basic problems are grouped roughly under the following headings: (1) conservation and utilization of natural resources; (2) development of systems of agriculture based upon improved efficiency; (3) development and maintenance of trade and communications among the Caribbean territories and colonies and with non-Caribbean areas; (4) provision of adequate housing and the improvement of public health; (5) full use of man-power in productive employment and the improvement of welfare among rural communities; and (6) broadening of education to include vocational instruction, the strengthening of public morale, and the promotion of 'self-help' and community co-operation.

The initial fishery survey is being followed up by a more detailed study in the south-eastern Caribbean, and commercial fishery research is being started. Special committees have already been formed under the Caribbean Research Council to report on land tenure and on the measures necessary to maintain diversified production. Arrangements have been made for the full collaboration of forestry services throughout the Caribbean with the United States Federal Forestry Research Institute in Puerto Rico, and the Research Council will assist in co-ordinating studies on forestry problems in the Caribbean and comparable areas. The Commission is giving attention to

* Report of the Anglo-American Caribbean Commission to the Governments of the United States and Great Britain for the Years 1942–1943. Pp. xi+94. (Washington: Anglo-American Caribbean Commission, 810 18th Street, North-West. London: Crown Agents for the Colonies, 1943.) 3*d*.

the removal of restraints to trade and travel between the British and the United States Virgin Islands. It has given full support to the work of the Federal Works Agency in Puerto Rico and the Virgin Islands, as well as to the programme of works projects drawn up by the Development and Welfare Organization for the British West Indies. At a conference in Washington in July 1943, it was decided that the Commission offered an effective medium for co-ordinating sanitation and health problems in the area, and a consultative committee was eventually formed for this purpose. Quarantine matters have received special attention, including the drafting of model quarantine legislation. This received detailed consideration at a Quarantine Conference in November 1943 under the auspices of the British West Indies Development and Welfare Organization in co-operation with the Commission. The primary objective of this Conference was to consider the adoption of uniform quarantine procedure throughout the British Caribbean Colonies in regard to maritime traffic, air navigation, and the adoption of model quarantine legislation.

Scientific workers will find particular interest in the detailed programme of research required on soil, water and forest conservation appended to the report on nutrition, agriculture, fisheries and agriculture which led to the formation of the Caribbean Research Council. In addition, the report itself includes detailed proposals for investigations on diet and health, food supply and nutrition, nutrition and public health, on animal husbandry, for which a long-range research programme is formulated, on fisheries, food processing, storage and marketing. Special stress is laid on research in animal husbandry, which has been wholly inadequate in the Caribbean; it is believed that no other investment would yield greater returns in terms of nutritional well-being than measures to increase the proportion of animal proteins in the diet, through improved and adapted animal husbandry and a stable and more efficient agriculture.

ROYAL COLLEGE OF SURGEONS

SCIENTIFIC REPORT

THE Scientific Report of the Royal College of Surgeons of England for the year 1942–43 gives the welcome news that no further specimens, Hunterian or College, were destroyed or suffered major damage during that year. The general condition of the specimens is satisfactory, but the task of looking after a large collection which is dispersed among various centres, some of which do not provide adequate or suitable accommodation, must be an arduous one, especially when so many of the staff are serving with the Forces. The need for better and more convenient accommodation for the specimens, with working room and technical facilities, is still urgent.

The report gives a list, covering six pages, of additions to the Museum, and an account of the research going on in the Bernhard Baron Research Laboratories under the direction of Prof. J. Beattie. During 1941–42 it was shown that plasma proteins can be removed rapidly from the blood-stream and can also enter the blood-stream very rapidly in considerable quantities. It was found that the rate of entry was so rapid that it could not be due to the synthesis of protein from amino-acids in the liver, and that plasma protein could be mobilized from tissues other than the liver. Since the end of 1942, the problem of increasing the rate of protein synthesis by the liver has been studied. Casein digests suitable for intravenous or subcutaneous administration are now being tried, with the object of increasing the rate of protein synthesis in the body. It is considered that such digests might be valuable for the treatment of burns, severe infections and fractures, in all of which conditions the loss of plasma proteins is considerable. The use of digests and pure amino-acids for the prevention of severe liver damage is also being studied.

In 1943 a study of toxic hepatitis was begun with the co-operation of the British and American Army authorities. It has been found possible to prevent the liver damage which occurs in syphilitic patients receiving arsenical treatment, and to reduce the period spent in hospital from 27 to 11 days and the convalescent period from three months to ten days.

Nerve injuries are being studied by a Leverhulme Research Scholar at Oxford and, at the suggestion of the Ministry of Health, a study was undertaken of raw materials which might take the place of absorbable catgut for sutures. A suitable raw material has been found, and this has passed laboratory and clinical trials. All the staff of the Buckston Browne Research Farm joined the Forces at the outbreak of the War, and the main laboratories there were taken over by the Emergency Public Health Service.

CLASSIFICATION OF ANTS

THE naming of the different species of ants and their classification into genera, tribes, subfamilies, etc., is but an artifice, a mere convenience, although an all-important one if we are to dispose of our knowledge of myrmecology to the best advantage. In fact, to-day, a knowledge of formicid nomenclature is essential to anyone wishing to make a reasonable acquaintance with myrmecology.

It is perhaps strange, then, that although some five thousand species of ants have been described and given names since the time of Linnæus, and these five thousand species distributed among approximately four hundred genera and four-score tribes belonging to eight sub-families, no myrmecologist has during the last thirty years published even a complete list of the ant genera, let alone any more comprehensive guide to formicid nomenclature. It is true that Emery in the "Genera Insectorum" (1910–25) covered the whole family, but although he provides the skeleton for the future taxonomic treatment of the group, it is sadly incomplete and in many cases out of date and inaccurate.

Emery lists only two hundred and sixty genera and fifty-three tribes, which he places in five subfamilies (*Dorylinæ* Leach, *Ponerinæ* Mayr, *Myrmicinæ* Lepeltier, *Dolichoderinæ* Forel and *Formicinæ* Forel) as against the modern eight; the three new subfamilies being the *Cerapachyinæ* Wheeler (previously a tribe *Cerapachii* Forel and later a section *Prodorylinæ* Emery of the *Ponerinæ* Mayr.), the *Leptanillinæ* (Emery) Wheeler, containing the solitary genus Leptanilla Emery earlier attributed to the *Dorylinæ* Leach, and the *Pseudomyrminæ* (Emery) Wheeler, previously considered as a tribe of the *Myrmicinæ* Lepeltier. Furthermore, the "Genera Insectorum" is scarce and difficult to obtain except at universities

and large institutions, where, of course, it may only be borrowed.

Wheeler's lists of the genera and their types (1911 and 1913) were therefore of great value, although incomplete and even more inaccurate than Emery's in the "Genera Insectorum".

The recent publication of Donisthorpe's "List of the Type species of the Genera and Subgenera of the Formicidae" (*Ann. and Mag. Nat. Hist.*, ii, **10**, 617, 649, 721; 1943) is therefore an event of considerable importance. For the first time there is an authoritative, complete (so far as is known) and easily obtainable list of the genera and subgenera of ants. Furthermore the tribe, subfamily and also, where it occurs, synonomy of each of the genera listed are given. The type species are listed in each case, together with the type locality.

It is difficult to review such a list without entering into detail which would be out of place here, but which I hope to discuss elsewhere. A few points may, however, be mentioned. The use of the generic name Lasius Fabr., a synonym for Acanthomyops Mayr (five species of which are found in Great Britain), perpetuated by Wheeler and Emery, should now cease for good and all. Fabricius's name sinks on account of Jurine's earlier one. Ruzsby's subgenus Lasius (s.g. of Lasius Fabr. Acanthomyops Mayr.) also sinks to Morrice and Durrant's Donisthorpea. It is nice to see Crematogaster Lund for once spelt correctly and not as in Wheeler's "Ants" (1910) and Forel's "Social World of the Ants" (London, 1927) with an 's', namely, Cremastogaster, which is meaningless. Emery's mis-spelling of Chtonolasius Ruzsby (copied by Donisthorpe in his "British Ants", 1927) has also been corrected.

The function of nomenclature is to aid and simplify the work of the zoologist, not to confuse him and make his task more complex. It is a mechanism for handling the data appertaining to, and not a fundamental part of, biology, and as such the taxonomy of a group should be well-ordered, comprehensible and easily accessible. Donisthorpe is therefore to be congratulated on this attempt to produce order out of chaos and to make accessible that which has been beyond the reach of all but the experienced myrmecologist—in fact, Donisthorpe himself and less than half a dozen others in the world.

B. D. WRAGGE MORLEY.

PELAGIC FORAMINIFERA

WE owe much of our recent knowledge of the biology of the Foraminifera to Dr. E. H. Myers. His new publication* is a peculiarly beautiful example of his work, embracing the complete life-cycle of Tretomphalus and its activities observed both in Nature and in cultures. The life-cycle includes an orderly succession of sexual and asexual generations in which two distinct types of individuals and three types of tests are involved. Typically benthonic microspheric (asexual) and megaspheric (sexual) individuals are produced, the latter becoming pelagic prior to the discharge of the gametes. The test of the pelagic phase has a globular terminal chamber, perforated by large pores, and contains a gas-filled float, the gametes passing out of the pores. The zygotes are formed by the fusion of gametes from different parents, the latter approaching one another and their amœboid pseudopodia anastomosing—an unusual occurrence in the Foraminifera. This association ensures the fertilization of a maximum number of gametes, which settle on the bottom and produce microspheric tests. So the life-cycle proceeds.

Tretomphalus is shown to be significant only as a convenient category in which to place the pelagic stage of species which are now included in either the genus Discorbis, family Rotaliidæ, or the genus Cymbaloporetta, family Cymbaloporidæ. Much confusion in nomenclature has been caused by the polymorphic nature of these tests, and this work should contribute largely to a more natural classification.

Observations on feeding show that swiftly moving organisms, such as nauplii, ciliates and veligers, are not captured, although these can be utilized as food when crushed and placed in the vicinity of the test. On the other hand, grazing on diatoms and other unicellular algæ on the walls of the dish is usual, and inclusions of these can be seen in sections. Similar sections of material from the sea show that the natural food is the microflora both from the water or on the substratum fixed on the surface where the animals live.

Interesting accounts are given of the formation and growth of the tests. Under optimum conditions in cultures maintained at 20° C., about forty-two days are required for an asexually produced individual to form a test consisting of 13–17 chambers.

The illustrations which accompany this paper, both photographs and drawings, are of great beauty and clarity, and special mention should be made of the photograph of dispersal of the juveniles and the disintegration of the empty test of the microspheric individual which produced them: also the figure of the life-cycle of *Tretomphalus bulloides*.

* Biology, Ecology and Morphogenesis of a Pelagic Foraminifer. By Earl H. Myers. Stanford University Publications. University Series. Volume IX. Number 1. Biological Sciences. Stanford University Press. 1943.

RECENT AMERICAN ARCHÆOLOGY

EUROPEAN archæologists are too often apt to forget that the prehistoric period continued in many parts of the world, America included, until about the day before yesterday. Moreover, just because the later time limit of the study is so recent, much more evidence can frequently be collected than in the case of the very remote cultures, and thus a picture in greater detail constructed. The fact, then, that Waldo R. Wedel's recent archæological investigations in Platte and Clay counties, Missouri (United States National Museum, Bull. 183), deal with finds which in western Europe would be classed as post-medieval in date, does not make them any less interesting or less important. The interest and importance of the ruins at Zimbabwe in Southern Rhodesia were not lessened when it was shown that their date was anything but prehistoric in our sense of the word.

Mr. Wedel is concerned with village sites and two kinds of burial mound. He suggests the presence in the area of two different cultures. One (the Renner village site is the type site) shows definite relationships with certain "Northern Elemental Hopewellian Manifestations" such as those found in the Illinois valley and south-western Wisconsin, the other (the Steed-Kisker site is the type station) recalls the Nebraska culture, characteristic of the Missouri River bluffs in eastern Nebraska and south-

western Iowa, being a local variant of the late Middle Mississippi culture. The stone-chambered burial mounds containing dolicocephalic remains are classed with the first-named culture, the earth mounds with the latter. Actually, at Steed-Kisker itself the dead were buried in graves and large earth mounds are absent. When contrasting the material culture from the two classes of sites, no very startling difference is observable, but there are distinctions noticeable in the pottery types, as well as in other classes of finds. An appendix on the types of human skeleton collected is written by T. Dale Stewart.

Once again we are dealing with local investigations on the more recent archæology of America. So much material having survived for this period in the New World, it is not yet time for a major work of synthesis, but volumes such as the one under review will be the source of information for future compilers of the history of the United States during the centuries immediately preceding the arrival of the Europeans.

M. C. BURKITT.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 13

SOCIETY OF CHEMICAL INDUSTRY (YORKSHIRE SECTION) (in the Chemistry Lecture Theatre of the University, Woodhouse Lane, Leeds), at 7 p.m.—Dr. T. H. Blakeley: "Graphical Methods of Treating Technical Problems".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre Swiss Cottage, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.15 p.m.—Dr. K. Weissenberg: "Chemical Constitution and Physical Properties of Materials".

Tuesday, March 14

CHADWICK PUBLIC LECTURE (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. S. A. Henry: "Medical Supervision in Industry in Peace and War".*

INSTITUTION OF CHEMICAL ENGINEERS (joint meeting with the CHEMICAL ENGINEERING GROUP) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. K. B. Marshall: "The Welded Joint in Non-Ferrous Chemical Plant".

PARLIAMENTARY AND SCIENTIFIC COMMITTEE (in Committee Room 14, House of Commons, London, S.W.1), at 3 p.m.—Discussion on "A Scientific Policy for British Agriculture, particularly in relation to Nutrition" (Speakers: Prof. F. L. Engledow, Prof. Miller and others).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. A. R. Todd, F.R.S.: "The Mode of Action of some Vitamins", 2.*

INSTITUTION OF CIVIL ENGINEERS (joint meeting with the INSTITUTION OF MECHANICAL ENGINEERS) (at Great George Street, Westminster, London, S.W.1), at 5.30 p.m.—Symposium on "Contractors' Plant".

Wednesday, March 15

INSTITUTE OF METALS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 11 a.m.—Thirty-sixth Annual General Meeting; at 2.30 p.m.—Dr. W. Hume-Rothery, F.R.S.: "Modern Views on Alloys and their Possible Application".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. J. N. Dean: "Gutta Percha and Balata, with Particular Reference to their Use in Submarine Cable Manufacture".

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (joint meeting with the PHYSICAL SOCIETY) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Dr. W. T. Astbury, F.R.S.: "The X-Ray Examination of Plastics".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Annual General Meeting. Prof. W. G. Fearnsides, F.R.S.: "The Practice of Geology" (Anniversary Address).

ROYAL INSTITUTE OF CHEMISTRY (at 30 Russell Square, London, W.C.1), at 3 p.m.—Annual General Meeting. Mr. P. A. Houseman: "Licorice—Putting a Weed to Work" (Streatfeild Memorial Lecture).

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, South Kensington, S.W.7), at 4.30 p.m.—Major H. C. Gunton: "Report on the Phenological Observations in the British Isles from December 1942 to November 1943".

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. H. W. H. Warren: "Electrical Engineering Research" (Student's Lecture).

Thursday, March 16

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Sir John Russell, F.R.S.: "Europe's Changing Peasantry".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. C. R. Harington, F.R.S.: "Newer Knowledge of the Biochemistry of the Thyroid Gland" (Ninth Pedler Lecture).

SOCIETY OF CHEMICAL INDUSTRY (AGRICULTURE GROUP) (joint meeting with the BIRMINGHAM SECTION) (at the Chamber of Commerce, New Street, Birmingham), at 2.30 p.m.—Mr. P. Parrish: "Our Fertilizer Industry; with Special Reference to Modern Methods of Manufacture of Calcium Superphosphates, Ammonium Sulphate and N.P.A. Granular Fertilizers".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Prof. H. W. Turnbull, F.R.S.: "Recent Advances in the Theory of Forms".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. Schiller: "An Analysis of the Load on a Modern Electricity Supply System".

Friday, March 17

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. Howard Marryat: "Evolution of the Pocket Watch".*

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. Dell: "Developments of Railway Signalling on London Transport".

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the APPLIED MECHANICS GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Symposium on "Some Modern Aids in the Investigation of the Behaviour of Materials, Mechanisms and Structures".

BRITISH ASSOCIATION OF CHEMISTS (NORTH-EAST SECTION) (in the Chemistry Lecture Theatre, King's College, Newcastle-upon-Tyne), at 6 p.m.—Dr. F. G. Mann: "Some Aspects of the Organic Chemistry of Phosphorus and Arsenic" (Tilden Lecture of the Chemical Society).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—The late Dr. W. H. Hatfield, F.R.S., Mr. L. Rotherham and Miss E. M. A. Harvey: "Further Experiments on the Damping Capacity of Metals".

Saturday, March 18

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Mr. W. J. Meredith and Dr. G. J. Neary: "The Production of Isodose Curves and the Calculation of Energy Absorption from Standard Depth Dose Data"; Mr. P. H. Flanders: "A Demonstration of an Optical Contour Finder".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 2.30 p.m.—Dr. H. M. Finniston and Mr. T. D. Fearnehough: "The Physical and Mechanical Properties of Segregates".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ELECTRICAL ENGINEER (location, Middle East)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.767A) (March 15).

CHEMICAL ENGINEER, to assist in the design and testing of plant for the manufacture of various chemicals, mainly organic—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2040.XA) (March 15).

TEACHER to teach mainly MECHANICAL DRAWING in the Junior Technical School, with some MATHEMATICS and/or WORKSHOP PRACTICE (wood or metal)—The Principal, County Technical College, Gainsborough, Lincs. (March 17).

ASSISTANT TO THE ADVISORY CHEMIST—The Chief Advisory Officer, Agricultural Advisory Department, The University, Manchester (March 18).

GRADUATE MISTRESS (MATHEMATICS) for Barrett Street Technical School, Oxford Street, London, W.1, and Maidenhead—The Education Officer, T.1, County Hall, Westminster Bridge, London, S.E.1 (March 18).

HEADMASTER OF THE PRE-APPRENTICESHIP COURSES FOR THE BUILDING TRADES recently established in Aberdeen—The Director of Education, Education Offices, Castle Street, Aberdeen (endorsed 'Pre-Apprenticeship School') (March 18).

PRINCIPAL—The Clerk to the Governors, Harper Adams Agricultural College, Newport, Shropshire (March 18).

PROFESSOR OF MECHANICAL ENGINEERING in the Benares Hindu University Engineering College—The Secretary, Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1 (March 18).

COMMISSIONS IN H.M. FORCES (a limited number) will be granted to candidates who are University-trained Biologists, preferably men with some experience of malaria or entomology—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. ONF.2057A) (March 18).

UNIVERSITY CHAIR OF ANATOMY tenable at St. Mary's Hospital Medical School—The Academic Registrar, University of London, c/o Richmond College, Richmond, Surrey (March 20).

TUTORS (2, men, preferably unmarried) at the Makerere College, Kampala, Uganda; Post 1, GEOGRAPHER to teach in New Arts Course, should be specially qualified on the Humanistic (i.e., Social and Economic) side of the subject; Post 2, CHEMIST qualified to teach both Organic and Inorganic and with a special interest in Biochemistry—The Secretary (IPR/CA), Board of Education, Belgrave Square, London, S.W.1, or The Secretary, Scottish Education Department (Branch Office), 29 St. Andrew Square, Edinburgh 2 (March 21).

CIVIL ENGINEERS by a firm of Contractors in the Near East—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. EA.803.XA) (March 22).

MUSEUM ASSISTANT (man or woman) IN THE DEPARTMENT OF ZOOLOGY—The Secretary, Bedford College for Women, Springfield, Sidgwick Avenue, Cambridge (March 22).

DEPUTY BOROUGH ELECTRICAL ENGINEER—The Borough Electrical Engineer, Electricity Works, Warrington (endorsed 'Application for Deputy Borough Electrical Engineer') (March 24).

TEACHER (man or woman) at the Cannock Chase Mining College, mainly for the daytime teaching of Science—The Director (H), County Education Offices, Stafford (March 25).

READERSHIP IN MINERALOGY—The Registrar, University Registry, Oxford (April 8).

WAYNFLETE PROFESSORSHIP OF METAPHYSICAL PHILOSOPHY—The Registrar, University Registry, Oxford (April 13).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

CHAIR OF PHILOSOPHY at the University of the Witwatersrand, Johannesburg—Dr. William Cullen, 4 Broad Street Place, London, E.C.2 (May 1).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

LECTURER IN MECHANICAL ENGINEERING at the Norwich City College and Art School—The Director of Education, City Hall, Norwich.

GRADUATE ASSISTANT to teach chiefly PHYSICS and MATHEMATICS in the Thomas Richards Technical Institute, Tredegar—The Director of Education, Higher Education Department, County Hall, Newport, Mon.

MATHEMATICS MISTRESSES (2) at the Jerusalem Girls' College, and a MATHEMATICS MISTRESS at the English High School, Haifa—The Secretary, Jerusalem and the East Mission, 8 St. Thomas Street, Winchester.

SENIOR LECTURER IN THE PHYSIOLOGY DEPARTMENT—The Secretary, University of Edinburgh, Summerhall, Edinburgh 9.

WOMAN GRADUATE to take charge of analysis of original material on food purchases and consumption and its presentation in statistical tables—Appointments Department, Ministry of Labour and National Service, Sardinia Street, London, W.C.2 (Quoting Reference No Q.M.33).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Ministry of Agriculture and Fisheries. Bulletin No. 127: Home Curing of Bacon and Hams; a Manual of Theory and Practice for Instructors and Others. Compiled by the Small Pig Keepers' Council. Pp. ii+57+4 plates. (London: H.M. Stationery Office.) 1*s*. 3*d*. net. [281

Institution of Electrical Engineers. Electricity Supply, Distribution and Installation: a Report to the Council from the Post-War Planning Committee. Pp. ii+26. (London: Institution of Electrical Engineers.) [301

Incorporated Association of Electric Power Companies. Memorandum wtih regard to the Electricity Supply Industry in Great Britain. Pp. 30. (London: Incorporated Association of Electric Power Companies.) [301

British Electrical and Allied Industries Research Association. Twenty-third Annual Report, October 1st, 1942 to September 30th, 1943. Pp. 130. (London: British Electrical and Allied Industries Research Association.) [12

Report of the London Chamber of Commerce on Scientific Industrial Research. Pp. 16. (London: London Chamber of Commerce.) [12

Occasional Publications on Scientific Horticulture. Nos. 1–3 (1939–42). Abridged edition, with Supplement. Pp. 100. (Sutton Bonington: Midland Agricultural College.) 4*s*. 3*d*. [32

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 17: Ascorbic Acid, Part 2: Factors determining Stability in Aqueous Solution. By Einhart Kawerau and W. R. Fearon. Pp. 171–180. 1*s*. Vol. 23 (N.S.), No. 18: Ascorbic Acid, Part 3: The Ascorbic Acid Content of Fruits and Vegetables Grown in Fibre. By Einhart Kawerau. Pp. 181–196. 1*s*. 6*d*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [72

Iron and Steel Institute. The Training of Metallurgists, with Special Reference to the Iron and Steel Industries. Pp. 32. (London: Iron and Steel Institute.) 2*s*. 6*d*. [72

Manchester Museum: University of Manchester. Report of the Museum Committee for the Year 1942–1943. Pp. 20. 6*d*. net. Museum Publications, New Series 2: New Greek Vases in the Manchester Museum. By Prof. T. B. L. Webster. Pp. 6+4 plates. 6*d*. (Manchester: Manchester Museum.) [72

Occupied Europe: German Exploitation and its Post-War Consequences. Pp. 75. (London: Royal Institute of International Affairs.) 1*s*. 6*d*. [82

City and County of Bristol: British Museum and Art Gallery. Report of the Committee for the Five Years ended 31 December 1943. Pp. 24+4 plates. (Bristol: Bristol Museum and Art Gallery.) [82

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 5, No. 5 (January—June 1943). Pp. ii+71–96. (London: Royal Meteorological Society.) 2*s*. 6*d*. [92

Forestry Commission. Post-War Forest Policy—Private Woodlands. Supplementary Report by H.M. Forestry Commissioners. (Cmd. 6500.) Pp. 12. (London: H.M. Stationery Office.) 2*d*. net. [92

British Standard Glossary of Terms used in Telecommunication. (B.S. 204, 1943.) Pp. 108. (London: British Standards Institution.) 3*s*. 6*d*. [102

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SEX TEACHING IN SCHOOLS

ONE result of war-time conditions has been the focusing of attention on the problems of sex guidance. This is not essentially a war-time question, and it should be viewed in perspective as part of the normal education of normal people in normal times, but the unsettled social conditions of recent years have brought the matter into prominence.

Among those who have been giving it attention are the rank-and-file teachers of Great Britain, who have expressed their willingness to play their part. This ferment has worked its way up to the top, and is beginning to produce results in the governing bodies of the various teachers' professional organizations. At their January meetings the Associations both of Assistant Masters and of Assistant Mistresses passed resolutions pledging their support, and now the National Union of Teachers has issued an important statement*.

The advance represented by this statement may be gauged by the fact that whereas in 1933 it was the considered opinion of the Executive of the National Union of Teachers "That the giving of class sex instruction is undesirable and against the best interests of the children in the schools", it is now concluded that "The position in relation to sex instruction has been considerably modified. Given the right conditions the information of the 'facts of life' can be taught in schools."

While recognizing that both teachers and parents have in the past tended to evade their responsibilities in this connexion, the pamphlet correctly reasons that "In the absence of a proper method of instruction, however, there is the real danger, too often experienced, that scraps of information or misinformation are liable to be whispered in a lewd or vulgar manner from one to another among pupils in a school"; and that "It would appear, therefore, that danger may lie less in the dissemination of knowledge than in its perversion and vulgar distortion."

Proceeding to a consideration of the content of sex education, the statement quotes with apparent approval an interesting paragraph from the *Health Education Journal*: "Sex education is more than the mere imparting of knowledge. Factual information is indispensable, but it is also necessary to interpret for the pupils the relationship between the facts of human physiology and the conventions of human society. Moreover, even an understanding of the origin and value of certain conventions will not ensure the living of a fine sex life. The children must be inspired with a feeling of the excellence of sex and of its immense potentialities. As in the pioneer days of widespread elementary education there was the slogan of the 'three R's', so sex education might well be characterised as the 'three I's'—sex information, sex interpretation and sex inspiration".

After pointing out that the nature study which is included in most school curricula provides a firm foundation for further instruction, the pamphlet then

* Sex Teaching in Schools. Statement by the Executive of the National Union of Teachers. Obtainable from the N.U.T., Hamilton House, Mabledon Place, London, W.C.1.

discusses the question of the extent to which school biology courses should deal with our own species. In this connexion it quotes the recent contention of Mr. Cyril Bibby (education officer of the Central Council for Health Education) that *Homo sapiens*, instead of being obscurely tucked in at the end of a course in which Amoeba, Hydra and Rana hold the places of honour, will be introduced in the first year of the post-primary school. Information about the biology of reproduction in plants and lower animals is an excellent adjunct to information about sex in humans, but is no substitute for it. It must be remembered that in many children there is an actual resistance against knowledge, due to fears and guilt-feelings, and if we leave a gap in our description they will fill it with the most fantastic imaginings. Children are interested in the functioning of their own bodies, and in a series of lessons on human physiology, sex and reproduction may be introduced in their proper place without undue emphasis. It is a sound principle that "reproduction should be regarded as a normal function of organisms, and no attempt should be made to isolate it or single it out for special attention".

The next problem is that of deciding who should be responsible for imparting the necessary information. It is recognized that parents should play an important part, but sight is not lost of the fact that "many parents do not give it and that many have neither the knowledge adequate for the purpose nor the skill to impart what knowledge they have". In these circumstances, the statement goes on to ask, "Should doctors or nurses be asked to visit the schools for this purpose ?" and gives a clearly negative reply. Many weighty arguments are marshalled against this proposal, all leading to the conclusion that "if this direct teaching is given, the teacher is the one on whom the duty is likely to devolve". It is very important that this point be borne in mind, for there are many who, while agreeing that sex education is desirable, tacitly assume that medical men should be responsible for it. By far the majority of medical men are not trained educationists, and there is also a real danger in bringing in a doctor, who still to the lay mind is associated chiefly with disease, to talk on something which is natural and healthy.

But the teachers themselves will need much preparation; and it is with pleasure that one reads recommendations 6, 7 and 14 of the pamphlet. These are of sufficient importance to warrant full quotation :

"6. Steps should be taken to ensure a greater supply of teachers fully qualified to teach biology and to afford facilities and provide adequate equipment for biological teaching to be given."

"7. Greater attention to the human aspect of biology should be given during teachers' training courses."

"14. Those teachers who wish to engage in the teaching of this subject should be afforded facilities for attendance at lectures or refresher courses to prepare themselves as fully as possible for the task."

Teachers will be faced with the decision whether to give instruction to individuals, to small groups, or to ordinary classes. The advantages and disadvantages of each type of approach are discussed, and although the pamphlet avoids any clear-cut decision, the weight of the argument appears to be in favour of dealing with sex in full class—even, it would appear, where the classes happen to be mixed.

Emphasis is quite rightly laid upon the importance of co-operation between teachers and parents; but it is doubtful if the Executive of the National Union of Teachers has quite caught up with the times when it states that "it is at the present stage of public opinion imperative" to "obtain the consent of the parent before it [that is, sex instruction] is given, and to make the position quite clear to all parents that if they do not wish for their children to receive the instruction they are fully entitled to say so, and the teacher will arrange accordingly". The fact is, that many schools do not ask prior consent, and that very rarely is there any complaint. Parents generally are overwhelmingly grateful to schools for dealing with this matter. Nevertheless, in some areas it may be wise to obtain consent.

It is perhaps pertinent to inquire whether the Executive has given sufficient weight to the arguments against granting this right of withdrawal. In the first place, the very act of asking consent can scarcely fail to imply that there is something a little doubtful about this instruction, something which makes it necessary to isolate it from the rest of the child's education—despite the emphasis to the contrary elsewhere in the pamphlet. The matter is considered in a recent article* from which we may quote: "Thirdly, a fine crop of problems arise if any replies to the question are in the negative.

(*a*) What do you do with the child who is not to attend the course ?

(*b*) What does the rest of the class think about this withdrawal ? Are all your careful plans to be frustrated as this subject is shown to be a queer, secret thing after all ?

(*c*) The child who is to be isolated will get the information from the other members of her class, second-hand, probably somewhat distorted and certainly in the wrong setting; her feelings of guilt will be intensified; her relationship with her parents will be marred.

(*d*) Further, the prohibition suggests that the psychological atmosphere in which the child lives is already difficult: if this is so, then the school seems to be her only hope. Where the parents say they wish to tell the child themselves, they seem to have left things rather late. Beginnings must be made in the home in early childhood; left until adolescence is reached, a barrier has been set up between parent and child that may be insurmountable: again, the school seems to be the child's best chance."

On the whole, however, the statement by the National Union of Teachers represents a marked step in the right direction, and, coming as it does from one of the most powerful professional organizations in the country, should bear very fine fruit.

* *Health Educ. J.*, 2, No. 1 (Jan. 1944).

THE NEW CYTOLOGY

Frontiers in Cytochemistry

The Physical and Chemical Organization of the Cytoplasm. Edited by Prof. Normand L. Hoerr. (Biological Symposia, Vol. 10.) Pp. vii+334. (Lancaster, Pa.: The Jaques Cattell Press, 1943.) 3.50 dollars.

THE well-known jibe that the specialist is one who knows more and more about less and less may be taken in its complimentary sense by workers in many branches of science. Those who are endeavouring to determine the biochemical nature and enzymic composition of the microscopic and submicroscopic components of living cells belong to this category, and now they are at least beginning to show signs of penetrating some of the mysteries which beset the isolation and identification of anything so small and so sensitive as the protoplasmic particles and granules.

Ten years ago, Dr. R. R. Bensley retired from active occupation of the chair of anatomy in the University of Chicago. During the preceding forty years he had contributed largely to the study of cytological problems, to glandular secretion, and to advances in histological technique. Among his distinguished pupils was E. V. Cowdry; and his successor is N. L. Hoerr. On his retirement from academic duties, Dr. Bensley began work on cytoplasmic components, which Dr. Hoerr considers to be perhaps the most significant contribution of a long and very active career. He celebrated his seventy-fifth birthday last year, and in honour of this event a symposium was held at Chicago in November. The theme was the chemical and physical organization of the cytoplasm, the contributors were all active and distinguished investigators in this field, and the present volume is the record of the papers given, which incidentally have been brought fully up to date and constitute a most useful and comprehensive collection, especially valuable in a field such as this where publications are liable to be scattered over very many journals.

Dr. Bensley's guiding principle has been the separation of separable things before proceeding to their analysis. In 1934 he succeeded in separating granules considered to be mitochondria in a state of purity from liver cells, a feat in which Warburg in 1912 had been partially successful and which enabled Warburg to state that these particles contributed to the oxygen uptake of saline extracts of liver. Later, A. Claude, and independently A. Lazarow in Bensley's laboratory, discovered and isolated yet smaller, submicroscopic particles contained in liver and other cells. All these workers make excellent contributions to the book; but their accounts would be much clearer to follow if they could agree to a common system of nomenclature. Thus the "mitochondria" of Bensley and his colleagues are the "secretion granules" of Claude, while the latter's "small particles" or "microsomes" are called "submicroscopic lipoprotein particles" by the Chicago school. Lazarow states that these smaller bodies are red; but Claude, who has got them from other sources besides liver, finds that they are light to dark amber in colour. They are about 50–300 mμ in diameter, whereas the larger granules are 0·5–1 μ. Although, as Claude has shown, both contain ribosenucleoprotein and phospholipins, there are quantitative differences in their composition. The larger granules ("mitochondria") disintegrate rapidly in distilled water, yielding submicroscopic particles closely resembling the "small particles" already mentioned. Possibly the latter are concerned in the formation of the larger granules, which contain, however, much less lipin. Both contain inositol to the extent of 2 per cent of the lipin content. The zymogen granules isolated by Claude from the pancreas closely resemble in composition and in their properties the larger granules described above.

So far, organic structures which exhibit the property of self-duplication seem to contain nucleic acid, as, for example, the viruses of plants, Shope papilloma virus, and, it is claimed, Rous chicken sarcoma agent and probably the mouse-milk cancer factor (Kahler *et al.*, *J. Nat. Cancer Inst.*, 4, 37; Aug. 1943). This prompts Claude to suggest that perhaps these particles isolated from cytoplasm, particularly the submicroscopic ones, may be endowed with this property also, and may participate actively in cell division.

These cytoplasmic components have, according to recent studies, distinct metabolic activities of their own. Hotchkiss and Hogeboom have shown that *d*-aminoacid oxidase activity is localized in the "secretory granules" but absent from the "small particles" of guinea pig and rat liver. Barron, who contributes a valuable 40-page synopsis of present knowledge of biological oxidation mechanisms, finds in experiments with Lazarow that partially separated mitochondria (secretion granules of Claude) oxidize succinic and glutamic acids, the latter more vigorously, but the nuclear concentrate is notable for its high succinoxidase activity, while the alcohol oxidase diffuses into the aqueous phase during centrifugation. Dounce has found that liver nuclei contain cytochrome oxidase, esterase, phosphatase, arginase, and lactic dehydrogenase, and more recently Lan (*J. biol. Chem.*, 151, 171; Nov. 1943) has added *d*-aminoacid oxidase and uricase to the list. Bartlett has shown that, while the tomato seed contains carboxylase, its coenzyme appears only on germination, and it is evident that if the type of technique now being developed could be applied to locating the origin of coenzymes and enzymes within the living cell, it would immediately acquire enormous potentialities.

K. G. Stern has an interesting chapter on various "macromolecular particles" which he has separated and analysed. Like much of the work described in this book, this is naturally an application of modern developments in high-speed centrifugation and other technical advances. The British reader is a little dazzled by the resources of this kind at the disposal of his American colleagues, so that it is something of a relief to find that Mirsky and Pollister, at the Rockefeller Institute, have a chapter in which they do quite a lot with a saline extract of tissue and "a glass rod with a crook at the base". With these homely accessories they seem to have separated nuclear nucleoprotein in a high degree of purity. Contrary to Stedman and Stedman (NATURE, Sept. 4, 1943), they believe that "threads of chromatin (chromosomes ?) assay practically 100 per cent nucleoprotein; that the nucleoprotein is, in fact, the substance of the chromosomes".

There is so much in this book that one can only catalogue other contributors here. These include N. L. Hoerr (isolation methods), H. W. Beams (ultracentrifugal studies), R. Chambers (intracellular 'Ringer' solution), E. V. Cowdry (cytology of carcinogenesis), I. Gersh and D. Bodian (histochemical changes in motoneurons), O. H. Lowry (cytoplasmic electrolytes), F. O. Schmitt, C. E. Hall and M. A.

Jakus (electron microscope studies on fibrils), and G. H. Scott (mineral distribution and localization in the cytoplasm). This excellently produced book contains a valuable collection of current individual adventures into the domain of the cell interior.

F. DICKENS.

REGIONAL EDUCATION

The Book of Buchan

(Jubilee Volume.) A conjoint Publication in five Sections on the North-East in Ancient, Medieval and Modern Times, by sixteen Contributors and eight Chapters by the Editor. Edited and arranged by Dr. J. F. Tocher. Pp. xii+330+44 plates. (Aberdeen: Dr. J. F. Tocher, 41½ Union Street, 1943.) 21*s*.

EDUCATION begins at home and, by stages which become more formal and circumscribed with each advance, proceeds to the primary and to the secondary schools, and for a fortunate few leads to the university. But outside the formal education, and for many more potent than it in building character and creating loyalties, almost as powerful as the home, is the influence of the geographical region in which impressionable years are spent. The Scottish clans were regional units, and it is this fealty to place which has been guided to the service of a wider patriotism in the territorial regiments, and which, so long as recruitment was more or less confined to the regiment's area and dilution by 'foreigners' was avoided, ensured for each regiment its own distinctive and cherished *esprit de corps*.

Although in the press of the ordinary school's curriculum the regional interest as a basis for the development of a wider instruction has scarcely found a place, it has nevertheless played a notable part in that education which begins when school-days end. It is represented in parish histories, such as Sir John Sinclair's "Statistical Account of Scotland" (1791) and its successor of the following century, "The New Statistical Account", in county histories, such as the ambitious "Victoria History" of English counties, and in innumerable local histories, of varied merit. The aim in every case is similar, to put on record regional developments and achievements and so, in deepening knowledge, to confirm and strengthen pride of place; and if this is to be done effectively the history must cover many aspects, and in such a manner as to appeal to the interest of the plain man.

In 1910 the Buchan Club issued such a history, "The Book of Buchan", to celebrate its majority. It was a local history fit to arouse the enthusiasm of the people of north-eastern Scotland. Now a second "Book of Buchan" commemorates the jubilee of the Club. Like its predecessor, it is edited by Dr. J. F. Tocher, who has skilfully contrived into a consecutive series the work of many contributors, using his own editorial articles as the constructional cement. Twenty-six articles elaborate or supplement the subjects of the earlier book, dealing in groups with the natural history, prehistory, literary, medical and martial celebrities, selected miscellanies of history and events.

The majority of the contributions are what they were intended to be, primarily of local interest, though the development of any region has its own significance to its neighbours and to the nation of which it forms a part. Of wider interest may be mentioned Prof. Gordon Childe's resetting of the prehistoric archæology of the district in the light of modern knowledge, the editor's records of the plague which, in 1647, caused professors and undergraduates of King's and Marischal Colleges to migrate respectively to Fraserburgh and Peterhead, Dr. Milne's account of the rise and decline of the whale-fishery of Peterhead, founded upon the publications of the late Dr. R. W. Gray, and Prof. R. A. Fisher's suggestion that with the gradual impoverishment in human quality of local areas, the character and destiny of each locality will come to depend less upon the regional spirit, and more upon the evolution of the nation as a whole.

The "Book of Buchan" is an excellent example of what may be done to consolidate a local heritage, in a region still markedly individual and distinctive.

JAMES RITCHIE.

PLANT TISSUE CULTURE

A Handbook of Plant Tissue Culture

By Dr. Philip R. White. Pp. xiv+277. (Lancaster, Pa.: The Jaques Cattell Press, 1943.) 3.75 dollars.

IT is rare, even in these days of specialized studies, that circumstances permit an investigator to present a 'first book' on pioneer work in any subject. This opportunity has come to Dr. White, and he has taken full advantage in the presentation of an admirable book. In the past, text-books of tissue culture have given the quite erroneous impression that only animal biologists have any interest in the subject or could derive anything of value from its study. Dr. White presents the case of the plant biologist, based on 457 references, with commendable force. He compresses into this relatively small volume the 'high spots' of plant tissue culture up to the present, in which he has himself played an outstanding part, and points out wide fields of interest for future research.

The most valuable part of the book, from a strictly utilitarian point of view, is undoubtedly the chapters dealing with matters of technique. Here we have, for the first and possibly last time, as befits a pioneering work, a most detailed description of the facilities necessary for starting and maintaining cultures, of the nutrient solutions needed, which Dr. White has himself set up as the accepted standard, and of a host of those small details of technique so vitally important and so often overlooked. Emphasis is rightly laid on scrupulous cleanliness, and here, as in the rest of the book, the fruits of years of experience are packed in a remarkably small space. For this section of the book alone, it is to be recommended to those who anticipate using this new tool, as a clear and stimulating exposition. Dr. White proves himself, however, more than a mere guide—he is also philosopher and friend—and the opening chapters in particular, dealing with the philosophical and historical approaches to the subject, are well conceived as placing this new technique in its true perspective against the general background of plant biology.

The last two short chapters are devoted to problems which have been attacked successfully by tissue culture methods; mineral nutrition and a study of nutrients generally both as regards their necessity for the maintenance of growth and as regards the quantitative reaction of tissues to specific doses of specific nutrients; water secretion in excised roots, giving a new stimulus particularly to the meaning and importance of 'root pressure'; tropisms in roots; growth of individual cells; and the effect of viruses

and other pathogens on the host tissue. Studies are described in the realm of morphogenesis, and this isolation of tissues from the morphogenetic influences of neighbouring tissues will undoubtedly form the soundest approach to questions of the effects of growth substances, chemical gradients, and so on.

It cannot be doubted that the isolation and successful growth of tissues is of great promise in many fields of plant science, or that the study has now reached the stage at which rapid advances are to be expected. It seems, in fact, probable that only the difficulties, real and imagined, of the culture of plant tissues has prevented the use of this method in many problems which can scarcely be solved by any other means. This book does much to remove these difficulties by emphasizing the precautions to be taken and the pitfalls to avoid, and its service to science in this way alone can scarcely be estimated at this time.

The book is to be heartily recommended to all plant biologists interested in new developments as a volume which can be read with pleasure as well as profit. It is illustrated by numerous photographs of excellent quality (including portraits of the principal workers in the field of tissue culture), and the presentation is of high standard. R. D. Preston.

ASPECTS OF REHABILITATION

Rehabilitation of the War Injured

A Symposium. Edited by Dr. William Brown Doherty and Dr. Dagobert D. Runes. Pp. 684. (New York: Philosophical Library, Inc., 1943.) 10 dollars.

During the past few years, the word 'rehabilitation' has come into common usage, but there does not appear to be a clear definition of its exact significance. This doubt is evidently shared by the contributors to this symposium, and we are presented, therefore, with articles based on almost every shade of its meaning. This variation in interpretation carries us from excellent chapters on the creation and maintenance of physical and mental fitness in those who have suffered from extensive war injuries, down to much less excellent sections upon highly specialized surgery.

There may be justification for considering that surgical repair is necessarily part of rehabilitation; it may, indeed, be all that is necessary. On the other hand, rehabilitation may more urgently follow conditions which do not require preliminary operation. That great part of the book, therefore, which deals with the technique of reconstructive and plastic surgery would seem to refer chiefly to those patients in whom no serious after-treatment is of importance. Parts of this section fulfil no particular purpose. They are couched in vague terms and end by being neither a technical description which might be of surgical value, nor yet sufficiently free from detail to make them valuable for anyone whose interest is not primarily surgical. Worse still, the contributors of some of these chapters have not considered it desirable to keep within the elastic limits of such a title as the editors have chosen, and have diverged to describe the treatment of defects which have no relation to war or its sequelæ. It may be that the writers themselves are not to blame for this, as it appears from the extensive list of acknowledgments that a great deal of the material has been collected from already published sources. This may also account for the very marked lack of clarity in the illustrations.

It should not be supposed, however, that this adverse criticism is applicable to the whole symposium. Many of the sections are concerned with specialized after-treatment which is rendered necessary by reason of some particular injury—the loss of sight, of hearing, or of a limb. Others deal fully with the specialized aspects of such treatment, and naturally enough the amount of stress laid on any particular method is in direct relation to the enthusiasm of its exponent.

The multiplicity and diversity of the views expressed are but an index of the magnitude of the problem, and one cannot help feeling that even if this volume does not answer the questions it raises, it should do much to stimulate coherent thought upon a subject which is, at the moment, only vaguely appreciated. In other words, when rehabilitation ceases to be a political catchphrase and is returned to the specialists who practise its component sections, we may well look forward to a great improvement in both the degree and duration of disability from which an injured man may suffer.

If this book is intended for the general public, it will, in the reviewer's opinion, leave them interested but somewhat confused. If, on the other hand, it is directed towards the medical profession, it should go far towards convincing them that the solution of the problem lies almost entirely in the integration of their various efforts into one harmonious whole.

SYMPOSIUM ON CANCER

Selected Papers from the Royal Cancer Hospital (Free) and the Chester Beatty Research Institute

Published by order of the Governors of the Royal Cancer Hospital (Free), London. Vol. 2. Pp. viii+414. (London: Royal Cancer Hospital (Free), 1943.) 16s.

Twenty-seven authors contribute to this symposium, which will be welcomed by all who have to deal with any aspect of cancer. The papers, some of which are highly technical, are reprinted from many journals and form four main groups: three of general clinical interest; four on radiation therapy; eight on calculations and physical measurements of radiation; eighteen on experimental research, and a review of the world literature 1938–1939 on chemical compounds as carcinogenic agents. The latter paper, by Profs. Cook and Kennaway, follows an earlier review on the same subject and is a masterly piece of work, including a bibliography of some five hundred new references. About half the volume is concerned with the synthesis and testing of chemical carcinogens and growth inhibitors. It is not yet certain that any of these substances are directly related to human cancer other than industrial cancer. A careful perusal of the results shows that many new facts could not have been established by studying only the earliest and best-known carcinogenic hydrocarbons. To the reviewer, the most interesting new experiments are those dealing with growth-inhibiting hydrocarbons that are not necessarily carcinogenic; with carcinogens that act on remote organs as well as locally; with those that show the need for more than one kind of biological test before a substance can be regarded as non-carcinogenic; and, particularly, with the extraction from human livers (not necessarily from cancer subjects) of unidentified carcinogens.

The scientific world owes much to this team and to the guiding influence of Prof. Kennaway, who was the first to prove that cancer could be induced by a hydrocarbon. P. R. Peacock.

ROAD ACCIDENTS AND ROAD STRUCTURE

By W. W. DAVIES

According to recently published information, 40,000 people were killed on the roads in the United States in 1941 and the cost of all road accidents during the same period amounted to little short of £500,000,000[1]. Comparable figures for Great Britain are not available, but the records of past years speak for themselves. In the ten years preceding 1940, 69,781 people lost their lives in road accidents and about 2¼ million people were injured. The most conservative estimate shows that the average cost of these accidents to the community, together with that of the much larger number of accidents involving damage, but not death or injury, could not have been less than £50,000,000 a year.

The figures for the two decades prior to the War show that the number of accidents was roughly proportional to the total number of vehicles using the highways (Fig. 1). In the case of the United States, up to 1938 the accident curve reflects quite remarkably the curve of the number of vehicles. The graph for Great Britain shows less faithful correlation, due to the increase in accidents in the 'bad' years 1931–34; but there is no significant break in the general relationship. The accident/vehicle ratio was 0·082 in 1925, and after reaching a maximum value of 0·098 in 1934, was again 0·082 in 1938.

There seems little doubt that the number of vehicles in Great Britain will increase two- or three-fold in the twenty-five years following the War, and that *unless novel methods of prevention are introduced*, the country will be faced with an annual casualty roll mounting steadily to some 500,000, representing an economic loss of the order of £100,000,000 a year. Road accidents, in fact, are a liability that the nation can ill afford at the best of times, much less with a man-power depleted by the ravages of war. Humanitarian motives apart, it is clear that on grounds of economy alone, the spending of very large sums of money on prevention will be fully justified.

The causes of road accidents are so numerous and complex as to defy all but the most detailed analysis[2]. As motor-vehicles are involved in some 85 per cent of the accidents, however, it is a reasonable simplification to say that the essence of the road accident problem is to find a way of neutralizing the 'accident-potential' of the motor-vehicle. Broadly speaking, this may be achieved in three ways:

(*a*) By reducing the lethal effect of the vehicle (for example, by automatic speed-control or by guard devices).

(*b*) By inducing greater caution and skill in the road-user by means of legal restrictions and penalties, and through education and propaganda.

(*c*) By improving the road structure (for example, by segregation, better surfaces, etc.).

Opportunities to reduce the lethal power of the vehicle are very limited; they probably do not go beyond minor improvements in steering and braking, and in providing a wider and less interrupted angle of view for the driver. A large proportion of accidents are stated to occur at speeds between 10 and 20 m.p.h., and although these figures may underestimate the facts, it would scarcely be practicable to reduce the speed-capacity of vehicles to the safety level (wherever

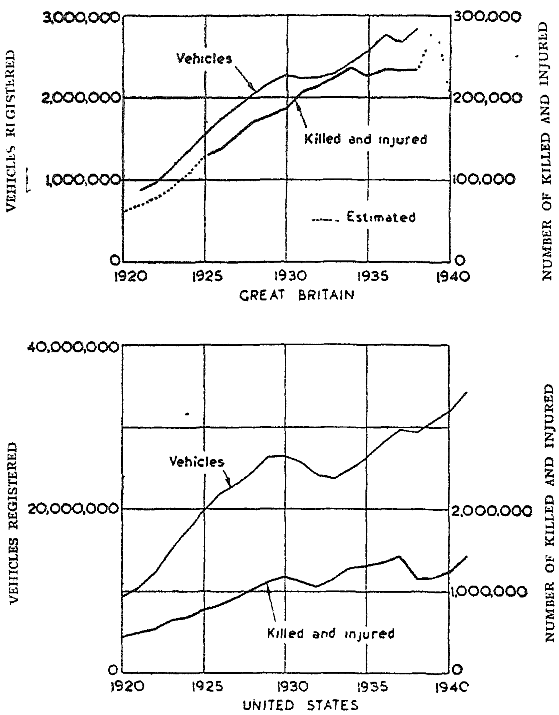

Fig. 1. VEHICLES AND ROAD ACCIDENTS IN GREAT BRITAIN AND THE UNITED STATES.

this may be) without enormously reducing the utility of road transport.

To 'improve' the road-user is at first sight an attractive proposition, and there is no doubt that a great deal can be, and will be, done to educate and restrain all classes of user. As the road structure is the theme of this article, the temptation to enlarge on this aspect of road safety must be resisted. We may note in passing, however, that all the campaigns and efforts on behalf of road safety of the past twenty years, although they have undoubtedly had beneficial effects, have notably failed, as the curves in Fig. 1 show, to reduce the overall accident/vehicle ratio below its value in 1925. Moreover, the reformer is handicapped by the nature of the weapons at his command; restrictive measures are unpopular because in most cases they have to be applied to the just as well as to the unjust; punishments cannot easily be devised which do not harm innocent people; and propaganda has to fulfil the almost impossible condition that it must be persistent without losing its novelty. While, therefore, improvement of the road-user must be regarded as one of the major objectives of the immediate post-war attack on road accidents, it would be unwise to anticipate sensational successes or to rely upon it to maintain a lasting effect.

Effect of the Road Structure

To consider now the restricted accident field imposed by the title of this article: What can be expected from improvement of the road structure?

The answer to this question in official statistics is, to say the least of it, discouraging; for "road conditions" (including the weather) are said to be the "sole or main cause" in no more than 5 or 6 per cent of the accidents. These statistics, however, are based on reports prepared by the police, whose primary job

is not to dissect the road accident problem but to assign responsibility; and it is fully realized that these do not represent the real part played by the road structure. For more illuminating evidence we must turn to authorities who are responsible for road conditions, and who have therefore made a special study of the effect of these conditions on road accidents.

The best-known example in Great Britain of the effect of the road structure is afforded by the experiments conducted by the County Surveyor of Oxford before the War in co-operation with the Ministry of Transport[3]. To test certain conclusions that had been reached by the County Surveyor, fifty-eight junctions on rural roads within the county were improved to the standard recommended in the Ministry's Memorandum 483 on the layout and construction of roads; and the effect on accidents was observed. In the twenty-one months following the completion of the improvements, there were no fatal accidents; non-fatal accidents involving serious injury were reduced by 79 per cent, and accidents involving minor injury were reduced by 37 per cent.

Another published example of the effect of road conditions in Great Britain is given in a paper read before the National Safety Congress by Lyddon in 1939[4]. The accompanying table, which is quoted from this paper, shows the effect on the frequency of road accidents of certain traffic control measures carried out at road junctions.

EFFECT ON ACCIDENT STATISTICS OF SOME PREVENTATIVE MEASURES AT ROAD JUNCTIONS

Type of improvement	Percentage of cases in which number of accidents		
	decreased	did not change	increased
Roundabouts: provincial	78	3	19
London	62	10	28
Island refuges: provincial	75	18	7
Light signals: provincial	53	9	38
Light signals (including a previous analysis)	47	10	43
'Halt' signs: provincial	76	13	11

While the figures show a reduction in accidents at most of the junctions, it is interesting to note that there was a marked increase in quite a large number of cases. This fact is significant in the light of comments to be made later.

In general, the evidence from the United States suffers from incompleteness of data, but two investigations may be mentioned as showing a fairly reliable trend. The first was concerned with the effect of 'safe-speed' signs (not used in Great Britain) in alleviating accidents on curves. The signs were erected in 1939 on a 95-mile stretch of highway in Indiana. Records of the accidents during a year before and after the installation showed that despite a 15 per cent increase of traffic, "there were 10 fewer fatalities and 12 fewer persons injured, 36 fewer accidents on curves and approximately $9,000,000 less property damage as a result of the erection of the signs"[5].

The second investigation was concerned with the effect of the colour of the road surface on night-driving hazards of a street in Philadelphia[6]. Here, for reasons not connected with safety, the tone of the road surface was changed from light to dark without any corresponding alterations in the character of the street-lighting. Examination of accident statistics showed that, whereas in six winter months preceding the change 232 accidents had occurred during daylight and 182 at night, in the corresponding period after the change the ratio was reversed, 172 accidents occurring in daylight and 211 at night.

The Case of a London Street

A very striking example of the effect of the road structure on the incidence of road accidents occurred in the course of an investigation, undertaken by the Road Research Laboratory as part of the programme of the Road Research Board, on the use of surface-dressings to reduce the slipperiness of certain types of paving in London. The Board being concerned with research on road materials and methods of construction, the tests were devised in the first place to examine the efficacy of a certain type of surface-dressing in terms of its durability and resistance to skidding. As the ultimate object of such treatments is to increase road safety, it was decided later to attempt to link-up the improvement made in the road surface with its effect on road accidents, and police records of all fatal, non-fatal and damage accidents involving vehicles before and after the improvement were examined. About a year earlier, island refuges had been installed on the same stretch of road, so the period of the statistics was extended to cover this feature also. Traffic records over the period of the review were not available; but there were no indications of any appreciable variation either of traffic density or of any other factor that might have affected the accident ratio.

The results of the inquiry are indicated diagrammatically[7] in Fig. 2, which shows the incidence of accidents between November 8 and February 7 in the three successive years during which the changes in the road conditions were made. Referring to the two areas under observation (hatched on the bottom diagram), the main conclusions were as follows:

(1) In the three months following the installation of the island refuges, a measure specifically intended to reduce accidents, 63 accidents occurred, compared with 24 in the corresponding period of the previous year.

(2) After the sections had been surface-dressed, the number of accidents on them fell from 63 to 4. In the same period there was a considerable increase in the number of accidents on other stretches of the road.

(3) Although the surface-dressing treatment had served only to reduce the slipperiness of the road surface, the proportional reduction of accidents (94 per cent) was far greater than the proportion of accidents previously attributed in police reports to skidding.

(4) Although measurements showed that the treatment had reduced the slipperiness of the surface only at low speeds (up to 10 m.p.h.), the treatment practically eliminated accidents on the lengths treated.

(5) Assuming the average cost of the accidents to be £10 per accident (a conservative figure) the initial outlay on the treatment was recovered in less than two months by savings on accidents. Assuming the surface-dressing would require renewal after two years, the savings on accidents would represent a 'dividend' in this period of 1,500 per cent.

A notable feature of these results is their unexpectedness. The installing of island refuges actually caused a serious increase in the number of accidents; while the surface-dressings, although having such a

limited effect on the slipperiness of the surface, reduced the accidents to negligible proportions. It is equally noteworthy that the police reports, because of the particular viewpoint from which such reports are prepared, failed to give proper emphasis to the influence of road conditions on the accident ratio.

How Science Can Help

From what has been said, it will be seen that far too little is known of the principles governing road safety and the relationship between traffic and road structure—for the simple reason that no organized and persistent attempt on a sufficient scale has been made to track these principles down. It is true that the police in many areas maintain accident maps; and by concentrating road improvements on the 'black-spots', local authorities are often able to secure a substantial reduction of accidents: but little attempt is made to collect the supporting data by means of which a local success might be translated into a general relationship. 'Belisha beacons' marking pedestrian crossings have been installed in the towns and cities of Great Britain: but who can say with certainty whether they have failed or succeeded in their object? There is much talk of the benefits to be derived from motor roads: but there is not a single piece of reliable evidence to show that motor roads would effect an overall reduction in the number of accidents.

Those are but a few of many examples of our failure to study the fundamental causes of road safety. To borrow a popular metaphor, our method of attacking the problem has been tactical in scope: its objectives have been limited and immediate, its methods simple and its instruments ready-to-hand. There is a growing realization that this is not enough, and that it must be backed up without delay by a strategic attack having fundamental and far-reaching objectives, using the precise methods and instruments of science, and envisaging remedies that may not be immediately applicable. Such a step, in fact, was envisaged by the Alness Committee in its recommendation that a Road Safety Research Board should be set up, so far as possible as an independent body but closely in touch with the various authorities concerned with road safety. The functions of the Board would be to conduct researches and to make recommendations. A Road Safety Research Committee has already been set up in the Union of South Africa.

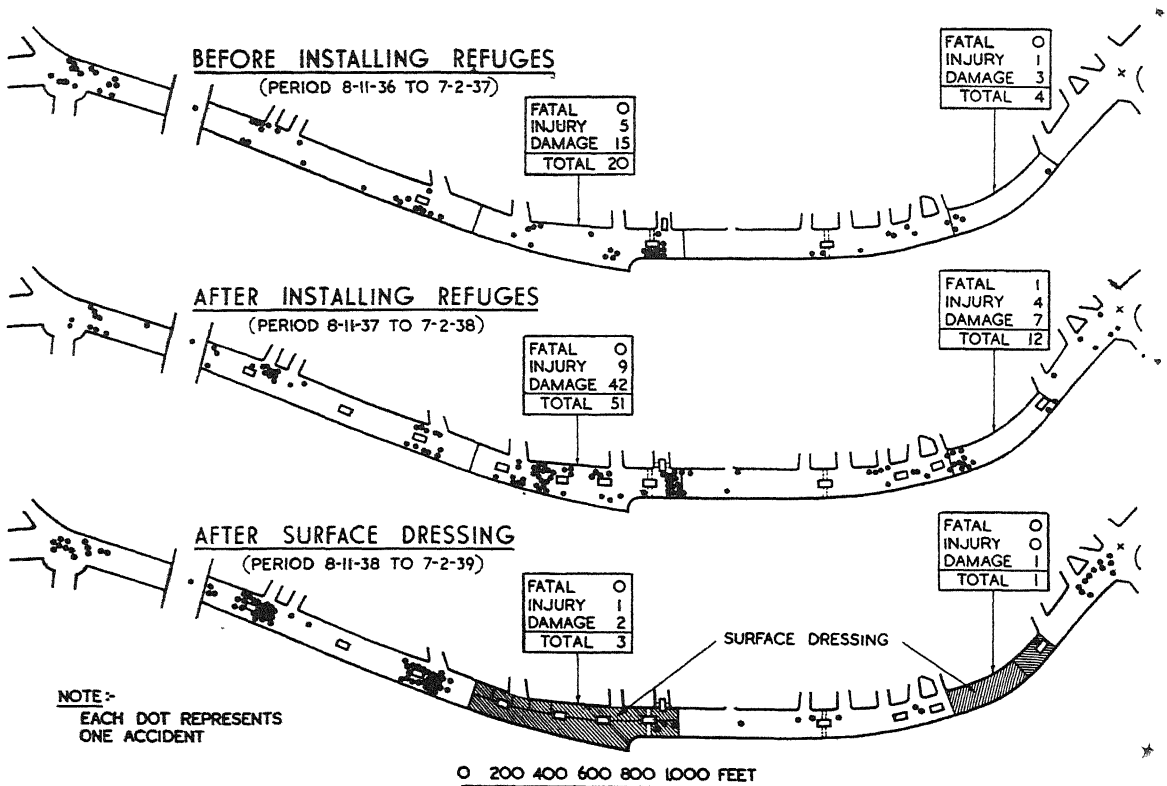

FIG. 2. RELATION OF ACCIDENTS TO ROAD CONDITIONS ON A LONDON STREET.

The field of investigation is obviously a wide one, and it embraces problems associated with the vehicle and the road user as well as with the road structure. Space permits only a brief reference to two or three aspects that concern road structure.

As there are 200,000 accidents yearly (omitting the large number of 'damage' accidents), and at least twenty-five major variables affecting the road structure alone, it is clear that the conditions for investigation are difficult and that a great deal will depend upon a proper use of statistical analysis. But contrary to general practice in the past, the statistics will have to be collected by trained observers, they must include not a few but many factors relating to the road, and they must aim at elucidating facts rather than apportioning blame. Since the accident/traffic ratio, rather than the actual number of accidents, is clearly of basic importance in a scientific

inquiry, parallel statistics relating to the type and density of traffic will also be required. The task is a formidable one; but it can no doubt be reduced to manageable proportions by sampling and by the use of standardized methods.

The scientific worker in partnership with the road engineer will also require a 'practical laboratory' in which the conclusions reached by theory and experiment can be tried out under normal working conditions and checked statistically. The area, or areas, might well be selected from those set apart for the statistical inquiry; and it would be necessary not only to avoid publicity but even to go to considerable trouble to conceal the experimental character of the site from the road user. As the behaviour of drivers is often conditioned by events in the recent past (for example, a 'narrow squeak' or a passing glimpse of the results of an accident) a careful watch would also have to be kept for possible 'edge effects'. Under properly controlled conditions, however, the true, as distinct from the local or temporary effects of modifications in the road structure, would in course of time be ascertained.

Finally, there is a large field for purely experimental research, in the laboratory as well as on the road. Perhaps the most important part of this work would be concerned with the relationship between the road structure and the movement or 'flow' of vehicular traffic. It is a curious thing that in spite of a quarter of a century of experience of modern road construction, very little is known of this relationship, and methods of design are still empirical. Making full allowance for the complications introduced by the presence of the human factor, it seems certain that definable laws govern the movement of vehicular traffic along the channel of the highway, and that they are dependent on the alignment and width of the carriage-way and the incidence of such intermittent elements as road junctions and traffic signs. It is the business of research to study these factors experimentally. By doing so, not only will valuable contributions be made to the solution of the problems of road safety, but also the information will help materially to reduce the overall cost of road transport to the community.

As O'Gorman, who has done much to direct public attention to the problem of road accidents, has said[8]: "What we want, what we lack and what we must have are measurements scientifically correlated, and analysed by competent persons".

[1] National Safety Council. "Accident Facts: 1942 edition." (Chicago, Illinois: National Safety Council, Inc., 1942.)

[2] A tabulated statement of the main headings of the road accidents problem, given by Glanville in the discussion of a paper at the Institution of Civil Engineers, contained thirty items, each of which could have been further subdivided. See, Rayfield, F. A., "The Engineer's Part in the Promotion of Road Safety", *J. Inst. Civ. Eng.*, **14** (7), 280 (1939–40).

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[7] Adapted from the report in the *Journal of the Institution of Civil Engineers* of the discussion referred to in footnote 2.

[8] O'Gorman, M., "Bringing Science into the Road Traffic Problem" (London: The British Science Guild, 1934).

CONTRACTION, TURGOR AND THE CYTOSKELETON OF NERVE FIBRES

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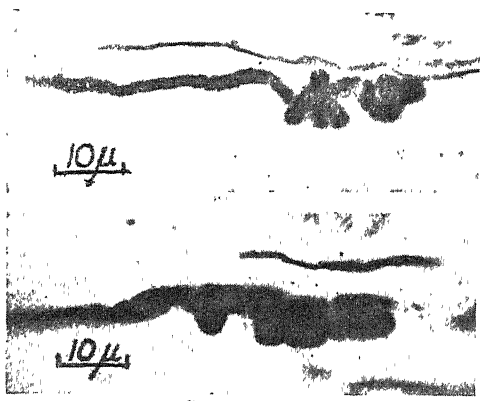
A STRETCH of nerve fibre which has been cut off from its cell body degenerates and disappears. There must, therefore, be some influence emanating from the cell body and nucleus which normally maintains the integrity of the axon. Two facts which throw light on the nature of this influence are that (1) during degeneration the isolated portion contracts and forms folds and spirals; (2) the central portion swells as if under the influence of a turgor pressure.



Figs. 1 and 2*. SPIRALS IMMEDIATELY BELOW A CUT MADE 48 HOURS PREVIOUSLY.

The contraction is shown most markedly in the region immediately distal to the cut, where the fibres contract back, often into quite tight folds and coils (Figs. 1 and 2). The more distant regions of the fibres remain intact for about two days (in a mammal) and then break up into granules, falling into loose spirals as they do so (Fig. 3). This contraction is presumably a manifestation of the process of disorientation of longitudinally arranged protein particles, the presence of which is shown by many other indications. The axoplasm shows a visible longitudinal fibrosity (the 'neurofibrils'), and birefringence studies indicate that part at least of the protein exists as micelles showing form and intrinsic anisotropy[1]. Electron microscopy of extruded squid axoplasm shows the presence of fibrils of all sizes from 15 mμ upwards[2]; distilled water or formalin coagulate the smaller particles into larger fibres[3]. The small amount of evidence available about the proteins of the axoplasm shows them to contain a complex resembling a nucleo-protein, from which a basic constituent like a histone or protamine can be split off[1].

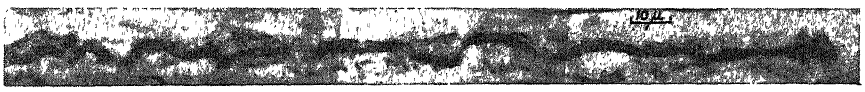


Fig. 3. MORE DISTANT PORTION OF AXON 3½ DAYS AFTER CUTTING.

It is therefore evident that the axoplasm contains orientated molecules. In the intact fibre these are

* All figures are of sections of rabbit's nerve stained by Bodian's method. They are arranged as if the cell bodies lay to the right.

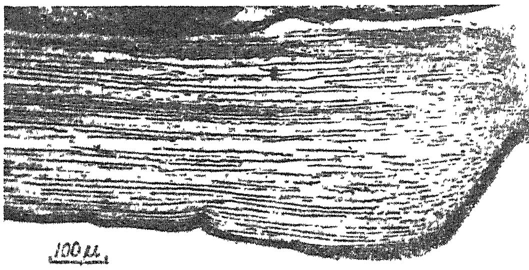


Fig. 4. PERIPHERAL END OF NERVE CUT FIVE MINUTES AFTER ALCOHOL HAD BEEN POURED AROUND IT.

somehow held in the extended condition, which is not the most probable one, so that when the constraining force is removed the disorientation is shown by the contraction, folding, disappearance of birefringence and break-up of the fibrous organization into granules. It is interesting that agents such as dehydration or heat accentuate the contraction. Very marked spirals are seen at the ends of nerves which have been immersed in alcohol just before cutting (Fig. 4). Schmitt and Wade[4] have shown that the shortening of nerves when heated is due to contraction of the axons and not of the supporting tissue.

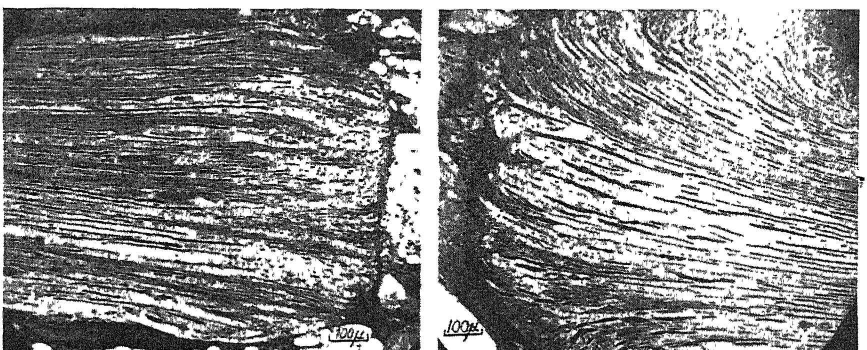
Since, when a piece of nerve is isolated, there is a disorientation of previously well-arranged particles, it may be suggested that the influence of the nucleus and cell body is to maintain this organization. Parker[5] has already suggested a connexion between the 'neurofibrils' and the 'trophic impulse' in an axon. A clue as to how the transmission may be effected is provided by the fact that the material in the central stump is under pressure. On the second day after cutting, the central ends of the nerve fibres are swollen and reach to the open ends of the endoneurial tubes in which they lie (Fig. 5). The peripheral ends, on the other hand, lie some tenth of a millimetre back from the cut surface and are little swollen. During the succeeding days the material of the central end flows out from the tube, forming one or several regenerating strands. These phenomena seem to show that there is a turgor pressure within the nerve fibre which must be transmitted from the cell body, since it is absent from the peripheral stump, although this is symmetrical with the central one except at the ends. The whole central stump is visibly more swollen than the peripheral[6,7], probably largely as a result of this intra-axonic pressure, although, as Weiss suggests, the swelling may be partly due to the accumulation of fluid between the nerve fibres, as a result of a centrifugal flow in the endoneurial lymphatic spaces.

Further evidence that there is a pressure and movement within the nerve fibres is the observation of Gutmann and Sanders[8] that during regeneration the diameter of fibres in the central stump decreases, while that of the fibres developing from them is increasing.

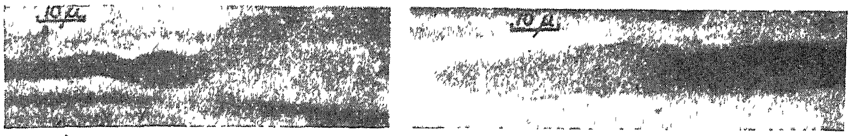
That the material of the axons is a fluid, or at least is thixotropic, is shown by the fact that it can flow freely and quickly from the ends of the large axons of Cephalopods[3], and by the movements which Speidel[9] has seen within it. We can therefore imagine the transmission of a turgor pressure along it, and this may well be important for several aspects of its functioning, including the maintenance of the orientation of its proteins. Studies on virus proteins and other materials[10,11] have shown that there are long-range forces capable of maintaining needle-like particles parallel to each other. Orientation in such solutions is produced by flowing and "the action of neighbouring surfaces, for example, in narrow tubes". Waugh[12] finds that the globular molecules of insulin may also form fibrous aggregates under mechanical stress.

The pressure could scarcely produce the orientation of the proteins originally, unless there is a definite continuous movement within the axoplasm. But the original orientation is produced during development, probably by the relatively rapid flowing which certainly occurs at that time. The influence of the cell body is to *maintain* the orientation, and it seems not impossible that it does this by the pressure which it produces within the axon. Comparison of the central and peripheral tips of the severed fibres certainly shows signs of disorientation in the latter (Figs. 7 and 8). Both may terminate in a lightly staining cap, but in the peripheral stump this contains a tangle of irregularly twisted or spiral threads, whereas the material in the central stump, besides being turgid, is also more orientated.

Of course, the fact that there is a disorientation during degeneration does not prove that the influence of the cell body is exerted directly by the maintenance of molecular orientation. The effect might be produced by a substance diffusing from the cell body which was necessary to maintain the metabolic activities of the fibre, and these in turn for the maintenance of the organization. Such diffusion has often been suggested, though no convincing evidence for such a substance has ever been produced. Hardy[13] considered that diffusion would be too slow, but Howe and Bodian[14] have shown that the virus of poliomyelitis spreads within the axoplasm at a rate of 2·4 mm. per hour; of course, the process need not be simple diffusion. A suggestion of correlation between the organization and the metabolism of a nerve fibre is the fact that isolated nerves which are stimulated become inexcitable sooner, and perhaps degenerate sooner, than those left at rest[15]. Gerard



Figs. 6 and 5. ENDS OF NERVE CUT 33 HR. PREVIOUSLY. IN THE DISTAL STUMP THE FIBRES END SOME WAY BACK AND ARE LITTLE SWOLLEN, WHEREAS THE TURGID ENDS OF THE CENTRAL FIBRES REACH TO THE CUT SURFACE. NOTE THAT THE CENTRAL STUMP AS A WHOLE IS OF MUCH GREATER DIAMETER.



Figs. 6 and 7. Central and distal ends of fibres from a nerve cut 48 hr previously

interprets this effect as due to the exhaustion of a supply of material normally diffusing from the cell body.

Hardy[13,16] suggested that organization within a cell might depend on an ordered arrangement of molecules originating at an interface and transmitted through quite large distances. Danielli[17] has a similar thought, that in muscle fibres the resting potential may orientate the outer molecules of the fibres, which in turn orientate those within. A similar relation might well obtain in nerve fibres, and would be consistent with the contraction and spiralling which are here discussed. However, since we know that the resting potential is maintained, at least for a time, in an isolated stretch of nerve, it cannot be regarded as an influence emanating directly from the cell body. The turgor pressure seems to be the only such influence for which there is some evidence, and it therefore merits serious consideration as the agent responsible for maintaining the organization.

It is even possible to suggest how the nucleus plays a part in maintaining this pressure. Gersh and Bodian[18] have confirmed the view of Caspersson[19] that the basophil Nissl granules contain nucleotides. After the application of ribonuclease, nerve cells lose the characteristic nucleic acid ultra-violet absorption band at 2600 A. Moreover, this band also becomes much less marked in cells undergoing the 'chromatolysis' which follows section of their axon. Gersh and Bodian suggest that after severance of the axon the intra-cellular ribonuclease breaks up the nucleotides, allowing the nucleoproteins of the Nissl substance to depolymerize and hence to produce the increased intra-cellular osmotic pressure which gives the turgid appearance to these cells and leads to the lateral displacement of the nucleus. It may be suggested that normally some such process goes on continually, and that it is the 'function' of the Nissl substance to provide the material the break-up of which increases the intra-cellular pressure necessary to maintain the organization of such long cells. This would explain the occurrence of such large amounts of extra-nuclear nucleo-proteins in these very large cells. It has often been suggested that after chromatolysis the Nissl substance is re-formed from the nucleus, and this has been confirmed by Hyden[20]. Possibly in this way the nucleus maintains a pressure within all cells, and hence perhaps the orientation of a 'cyto-skeleton' of proteins. There have been many indications in recent years of the importance of such a 'cytoskeleton'[21,22,23], but we lack definite information about its connexion with either metabolism or the control exercised by the nucleus over the cell.

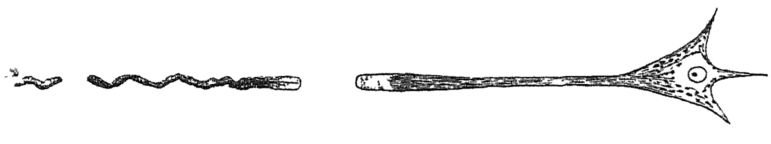


Fig. 9. Diagram to show appearances in central and distal portions of a nerve fibre during the days following section.

No doubt these relations will prove to be much more complex than are here suggested. But at least we have two significant and probably connected facts (summarized in Fig. 9): (1) there is a turgor pressure transmitted from the nerve cell body, and (2) degeneration of severed parts is accompanied by the disorientation of a protein framework.

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OBITUARIES

Dr. F. D. Chattaway, F.R.S.

The death of Dr. F. D. Chattaway, which took place at Torquay on January 26, severs another of the few remaining links between organic chemistry in Great Britain and the great school of the subject built up by von Baeyer at Munich.

Frederick Daniel Chattaway was born on November 9, 1860, at Foleshill, Warwickshire, and was the eldest of the five children of Daniel Clarke Chattaway and Eliza Ann Adcock. His father was a ribbon and trimming manufacturer in Coventry, and the collapse of this trade which followed the treaty with France in 1870 caused the family a very severe loss of income. As a consequence, Chattaway's scientific education was achieved almost entirely by means of scholarships; while as a further consequence he thereby gained an experience of universities and colleges wider than falls to the lot of most men. He received his early education at a school kept by a Nonconformist Minister, the Rev. J. L. Withers, who fostered his taste for natural science—a taste which had already been stimulated by his grandfather. His scientific education proper began at Mason College, Birmingham, where he was a pupil of Sir William Tilden. From there he went to University College, Aberystwyth, for two years, and then won a scholarship to Christ Church, Oxford, where his tutor was A. G. Vernon Harcourt. He took his degree with first-

class honours in chemistry in 1891, and then proceeded to Munich to work under von Baeyer and Bamberger.

On his return to England, Chattaway became a demonstrator in the Chemical Department of St. Bartholomew's Hospital Medical School, being appointed head of the Department when Dr. Russell retired. He left St. Bartholomew's in 1905 and again went abroad, this time to Heidelberg, where he studied under Bredig, and to Utrecht to work with Ernst Cohen. During this period, while he was in Holland, he was elected into the Royal Society.

Back in England he settled in Oxford, where in 1909 he took over from Cronshaw the chemistry teaching at Queen's, of which College he became in due course fellow, tutor and praelector in chemistry. He retired from teaching in 1935, remaining, however, a supernumerary fellow of Queen's until his death.

Chattaway was once described by an Oxford colleague as a "true-blue organic chemist", and the description fitted. Although his sojourn on the Continent from 1905 onwards was the result of his desire to acquaint himself with the then new subject of physical chemistry, he never really took to, or sympathized with, physical methods as applied to organic chemistry, preferring always the "beautiful crystalline body" which could be handled and investigated directly, and so with a greater feeling of reality. It was, in fact, in the production of such materials that a large part of his practical skill lay: few men excelled him in the ability to produce pure crystals from the most unpromising tars.

Within the realm of organic chemistry as he understood it, all was grist to his mill. Always his interest was in the way substances reacted together, and in the elucidation of the constitution of any hitherto undescribed products of a reaction. Here again lay one of his gifts; for he had a knack of choosing the correct alternative for synthesis, where doubt was still possible after degradation experiments, in a way reminiscent of Medicus's famous pronouncements on the purines. But he was no mere 'paper chemist': in the laboratory his industry was prodigious and his enthusiasm unbounded and infectious.

Chattaway's earliest work was done with Bamberger at Munich, and resulted in the determination of the constitution of a number of polynuclear hydrocarbons which occur in minute quantity in the highest boiling fractions of coal tar. His patience and tenacity were early shown in this work, which was both laborious and difficult, by reason of the intractable nature of the materials concerned and the very small quantities available. Later, his interest was caught by nitrogen iodide, and a series of thorough investigations enabled him to settle several hitherto doubtful points in its chemistry. He later prepared and examined exhaustively the properties of a very large number of N-substituted halogen derivatives of acylanilides, and championed with great vigour the view that the change which occurs when they are treated with acids is an intra- and not an inter-molecular change. He then became interested in organic perhalides, particularly those of the diazonium compounds, and in all aspects of the chemistry of hydrazines and hydrazones. He also investigated the nitration of benzil, condensation reactions of azides, many cases of polymorphism, and the stereoisomerism of thioparachloral derivatives, while his most recent work on condensation products of chloral and related compounds revealed a ready means of making derivatives of the benzdioxin ring system.

Chattaway's delight in the *practice* of organic chemistry was never dimmed and he only gave up the long hours of work in the laboratory (and then grudgingly and regretfully) when advancing age and circumstances left him no alternative. A small army of pupils owes to him a training in the methods of organic chemistry which could not have been excelled.

Dr. Chattaway married in 1894 Elizabeth Bettney, second daughter of Thomas Bettney, of Handsworth, Birmingham, who, with a daughter, now survives him. Their only son, a scholar both of Eton and of Christ Church, was killed at Thiepval in 1916.

G. D. PARKES.

Prof. Alfred Stansfield

THE announcement of the death on February 5 at the age of seventy-two of Prof. Alfred Stansfield, for thirty-five years Birks professor of metallurgy at McGill University, Montreal, has recalled to many of his friends and associates the outstanding contributions made by him to the progress of physical metallurgy in Great Britain while collaborating with Sir William Chandler Roberts-Austen at the Royal Mint and also at the Royal School of Mines.

To Stansfield was due in no small measure the actual experimental work and the improved means of pyrometric measurement (including the 'null' and 'differential' methods) which constituted such remarkable features of the Third, Fourth and Fifth Reports made by Robert-Austen to the Alloys Research Committee of the Institution of Mechanical Engineers, in 1895, 1897 and 1899 respectively. An important appendix to the Third Report, on "The Pyrometric Examination of Alloys of Copper and Tin", appeared under Stansfield's name. Its importance at that time can scarcely be over-estimated. Not only did it represent the first recorded attempt to give as 'freezing-point curves' an explanation of the copper-tin series as a whole, but it also marks the beginning of all investigations which have since been made in correlating the physical and mechanical properties of alloys with their equilibrium curves. Stansfield, in fact, a few years later, himself suggested the adoption of the term 'equilibrium curve' for metallic alloys, a term which had hitherto been restricted to the consideration of fused salts and saline solutions.

Stansfield's most striking and convincing contributions to physical metallurgy, however, were those by which he participated in the discussions in the late 90's on the "Solution Theory of Carburised Iron". Of the two papers by him which appear in the *Journal of the Iron and Steel Institute*, 1899 and 1900, it can well be said that these constituted a remarkably clear enunciation of the problems involved in a proper understanding of the relations between carbon and iron within the ranges covered by steel and cast iron. The latter of these two papers was presented and discussed jointly with the well-known contribution by Bakhuis-Roozeboom on "Iron and Steel from the point of view of the Phase Doctrine". Stansfield expressly set out to dispel the tendency to regard the solution theory as being, in a sense, opposed to, or as supplanting, the older allotropic theory. His paper, he hoped, would effectually dissipate such an error by showing how entirely the solution theory of the relations of carbon and iron involves the allotropic changes with which the distinguished name of Osmond is inseparably connected. Roberts-Austen, who was at that time president of the Iron

and Steel Institute, commended Stansfield's work in terms which now appear as being prophetic. He said: "He considered Dr. Stansfield's communication to be about as important as any that could well be made to the Institute. Its full significance might not be understood for months or even for years but it did afford a scientific basis on which the theories and practice relating to the metallurgy of iron might be built up".

Prof. Stansfield's subsequent work in Canada included, among other important matters, notable contributions to the technology of electric furnaces and of their application to electric smelting. This work has received wide recognition and is probably more familiar to those of later generations than his earlier work in Great Britain to which this note is intended more particularly to direct attention.

S. W. Smith.

Prof. James Young, O.B.E.

James Young, who retired from the professorship of science at the Royal Military Academy, Woolwich, in 1925, died on December 2, 1943; he was born in Ulster in 1862.

Young joined the Royal Military Academy in 1889 as instructor in chemistry. When war started in 1914, the authorities had ordered that all non-military subjects should be shut down; but Young had no difficulty in persuading a sympathetic commandant that science was a necessity, not a luxury, and the order was quietly ignored. With the small time available in a much shortened course, Young did great work, which was rewarded by the O.B.E.

When Young came to the Royal Military Academy, science there was little but chemistry applied to explosives. The Academy had been early in the field with chemistry. It was first taught there in 1789, and one of its teachers for thirty years had been the great Faraday himself. Electricity came in 1893, and Young wrote an Army handbook on that subject later on.

Young did little research, but great teaching work for the Army, and it was as unobtrusive as it was useful. He was far-sighted in his ideas of science in warfare. When wireless telegraphy was in its infancy, he put it in the curriculum, predicting its great future in the field. Also, within a few days of the first German gas attack, he was giving lectures on poison gas which became famous in the Army, and predicting that mustard gas would be the most effective.

Young was rather a recluse, and perhaps rather too gentle with his high-spirited students, though he earned their respect from his clear and original lectures, and is remembered with affection by many who are now officers of high rank. Particularly well remembered are his lectures on explosives, with their terrifying bangs, by which he made everyone realize how safe explosives are when handled with understanding; he was highly successful in giving his students the confidence due to knowledge. No one ever had an accident under his care.

NEWS and VIEWS

Science and Industry in Great Britain

A series of meetings on science and industry has been arranged by the Manchester Chamber of Commerce. The first of these meetings, on March 3, was addressed by Lord Riverdale on "Research and Industry: the Need, the Ways and the Means"; the second, on March 16, by Dr. A. P. M. Fleming on "Research Workers: their Education, and their Place in Industry". At subsequent meetings on March 31 and April 20, the speakers will be, respectively, Dr. Andrew McCance on "The Application of Research" and Sir Edward Appleton on "Fundamental Research: its Practical Importance". The meetings, admission to which is by ticket, are being held in the Houldsworth Hall, Deansgate, at 11.30 a.m.

At the first of these meetings, which was attended by several hundred business men, Lord Riverdale gave an outline of the work of the Department of Scientific and Industrial Research, and more particularly of the activities of the research associations in Great Britain, which at least hinted that when publication of the annual reports of the Department is resumed, it will be found that the research association movement has gained new vitality. Lord Riverdale gave a list of twenty-two existing associations and stated that several others are in process of formation. The provision of means and the formation of research associations, however, are not enough. Until individual firms use these means and become imbued with a full appreciation of scientific research and translate it into highest quality products, full benefit to firms and the community has not been achieved. Much remains to be done, especially in those industries containing many small units. Lord Riverdale is not satisfied that the Department can 'put over' the results of its research sufficiently dramatically, or that members of the associations really take an interest in it; the Department is now creating a public relations officer to meet this need. He also thinks that the question of invention requires further attention. Unless we have an authority with sufficient funds and able staff to watch inventions, see how they react on research in progress here, and make some attempt to introduce them to a concern which will test them effectively as to whether they are not of national importance, there is serious danger that we shall not be able to hold our own. Lord Riverdale also referred to the importance of obsolescence and of allowance being granted by the inland revenue authorities and the Treasury for expenditure on buildings and equipment for research—a matter in which he was strongly supported by Sir Raymond Streat, who also emphasized the implications for industry itself.

Lord Riverdale's address showed that the present outlook of the Advisory Council for Scientific and Industrial Research is in full harmony with that inspired by Lord Balfour and Lord Rutherford. While he did not disguise the dangers ahead and the necessity for Great Britain to increase its visible exports at least another two hundred millions if it is to continue to enjoy imports of the same value as before, he pointed out that, to an ever-increasing extent, the value of British exports must lie in the superior ability of our scientific men and technologists, the

keener enterprise of our industrialists and the higher skill of our workmen. Experience of the War has shown that Great Britain is second to none in the fields of scientific discovery and invention, and industrialists have shown that they are capable of translating the results of research rapidly and efficiently into products required for the successful prosecution of the War. This high quality of research is one of the surest grounds for confidence in our ability to meet successfully the difficult times that lie ahead.

Taxation and Research

REFERENCE has been made in various recent reports on scientific research and industry to the financial aspect in its relation to taxation. Thus the London Chamber of Commerce report (see NATURE, March 11, p. 294) advocates that expenditure on research should be chargeable on revenue. The matter has also been taken up by the Parliamentary and Scientific Committee, which has prepared a memorandum on the subject. This memorandum urges that the Government, in considering its taxation policy, should look to the prospect of benefiting from higher income tax returns when industry, as a result of the development, through research, of new processes and products, is made more profitable. The recommendations, however, are intended to afford a basis for discussion rather than to represent rigid and final views, and in particular the Committee wishes to learn the opinion of the revenue authorities on the practical reactions of its proposals. In general, it is recommended that the law relating to the taxation of profits should be amended so as to recognize the principle that all expenses incurred on research and development are allowable as deductions from taxable profits, with the corollary that receipts from a lease or sale of discoveries should be brought into taxable profits. It is also suggested that an allowance should be made for taxation purposes of a fixed percentage of any capital assets which have been provided solely for research purposes. The Committee also supports suggestions made by representative trade bodies to the Inland Revenue Committee regarding the amortization of business premises and machinery generally. Depreciation rates should be increased so as to include obsolescence, which has become a more important factor than wear and tear.

British Radio Research Institute

THE British Institution of Radio Engineers recommends the formation of a British Radio Research Institute, the functions of which would be the pursuit of basic research of the type that has hitherto suffered restriction owing to its high cost, absence of obvious or immediate practical applications, or the poor prospect of early financial returns. The institute should be financed by industry supplemented by a Government grant of at least equal amount. The work of the institute should be directed by a board representing Governmental authorities, the B.B.C. and the Services, the industry, the British Institution of Radio Engineers, the associated professional institutions and the universities of the Empire. In addition to a permanent scientific staff, the assistance and engagement of extra-mural workers should be arranged in co-operation with industry and the universities.

The advantages to be derived from the proposals are that the advancement of radio and electronic sciences would be freed from the limitations of restricted finance, duplication of original research work, spasmodic trade fluctuations, etc. Competitive private enterprise would be stimulated and the intake of high-grade technical personnel increased. It would remain with private enterprise to develop the practical and industrial applications of the scientific results flowing from the research institute. The pre-war hiatus between industry, the Government and scientific workers would be effectively bridged by the proposed governing board. New knowledge, carrying with it the possibility of new industries, would be continuously sought and be available for the free use of manufacturers to develop practical applications of the scientific principles. The necessity for private research departments would not be reduced; but the availability of undeveloped basic knowledge would give such departments a far greater opportunity for returning a dividend. The application of radio technique to fields other than broadcasting is capable of considerable development, and therefore the potential absorption of labour is considerable.

On the financial side, the contribution of industry to research associations was increasing before the War, and support is now being given to the principle of larger contributions being made in the future. Assuming the turnover to be only £20 million for the radio industry, an allocation of 0·25 per cent would give, with Government assistance, an income comparable with that of other research associations. If subscribing membership is open to all British industrial undertakings in the British Commonwealth which produce, manufacture or use electronic equipment, the income of the research institute would be comparable with the support given to any other association, while at the same time making the field of research inexhaustible. During the War, radio has graduated into a highly important industry. In the post-war era it should be supplying capital goods on a scale equal to many of the older industries; not only should the range and quality of its consumer goods be very different from anything known before, but also essential instruments and devices for other industries must be provided if British scientific and industrial progress is to be maintained. For all this development co-operative research is essential. It is strongly advocated by the Institution that opportunity for participation in the work of the research institute shall be provided for all countries in the British Commonwealth. Such collaboration in research will materially aid development of communications and the prosperity of the entire Empire.

Fuel for Household Use

ON February 18 Mr. J. G. Bennett, addressing the Fuel Luncheon Club in London on "The Future of Coal for Small-Scale Uses", compared raw coal, town's gas and electricity for household space heating. The comparison was based on heat costs incurred in production and distribution and the efficiency in use of gas and electricity when these are produced from coal. The results for all three, with appliances of current type, turned out to be identical —16 per cent of the heating value of the coal. Developments anticipated in appliances were estimated to increase these figures to 45 per cent for coal burnt in open fires, 24 per cent for gas and 33 per cent for electricity. Some may read into these figures the implication that no fuel-saving can be expected from the processing of coal before use. It should, however, be recalled that coal-less countries import

large quantities of coal for carbonization to produce gas and coke. It is unlikely that they are unanimously thriftless. Attention should be paid to the difference in the method of calculation. In the case of coal and electric fires, the resulting heat is usually a product of the raw coal. Gas, however, is derived from the volatile matter only, which is not more than one third of the whole of the coal. Then nearly the whole of the heat cost of processing is charged against this gas, and the end efficiency figure is reduced to one sixth. Even then, the efficiency figure is not less than the figure given for coal and electricity. Unlike, but over and above these, there remains some half-ton of coke available for domestic and industrial uses for which raw coal is unsuitable. At the moment, the Ministry of Fuel and Power is taking advantage of this reserve.

Mr. Bennett mentioned that the financial importance of the by-products of coal is apt to be exaggerated. This is true, but their usefulness should not be depreciated. Tar components amount to about 6 per cent by weight. They are, however, components of smoke and soot. As such, they are better recovered fit for uses which would otherwise necessitate importation of bituminous material. In this connexion it is interesting to take note of the views put forward by Harold Moore, only a fortnight earlier, in a paper read before the Institute of Fuel. This was a plea for a plan to meet the national needs for liquid fuels and organic chemicals. In addition to the development of home refining of petroleum, he considers that the most important feature of the plan should be the extension of coal carbonization. To promote this, he even advocates legislation against burning raw bituminous coal.

Basic English

MR. CHURCHILL announced in the House of Commons on March 9 that the Committee of Ministers on Basic English has submitted a report which has been approved in principle by the Government. So far as concerns the use of Basic English as an auxiliary international language, the Government is impressed with the great advantages which would ensue from its development, not in substitution for established literary languages, but as a supplement thereto, and is taking steps to develop its use as an auxiliary international and administrative language. The British Council will include the teaching of Basic English in addition to its more general activities in promoting the teaching of English for its own sake. Diplomatic and commercial representatives in foreign countries will be asked to do all they can to encourage the spread of Basic English as an auxiliary language. It is also intended to arrange for the translation into Basic English of a wider range than is at present available of literature, scientific, technical and general, both from ordinary English and from foreign languages, and also to increase the supply of manuals of instruction in Basic English. Some Colonial Governments will be invited to issue handbooks in Basic English for Colonial peoples on agriculture, hygiene, etc., and to use it in some administrative instructions. The British Broadcasting Corporation has been asked to consider the use and teaching of Basic English in appropriate oversea programmes. Primary responsibility for questions affecting Basic English and for giving effect to the recommendations of the Committee of Ministers will rest with the Foreign Office through the British Council.

Technology of Tea

DR. E. B. HUGHES, past-president of the Society of Public Analysts and Other Analytical Chemists, was unable to deliver his presidential address when he retired from office last year. Accordingly he delivered it after the annual general meeting of the Society held on March 1, speaking on "The Technology of Tea". Tea-growing areas are not now confined to Asia ; the necessary tropical or subtropical conditions exist elsewhere and tea is now grown extensively in Africa, even so far south as Natal, and also in Russia. In the production of black tea, as distinct from green tea, the main processes are withering, rolling, fermentation and final drying. Withering is a partial natural drying process at as cool a temperature as possible. It dries the leaves to a condition in which they can be rolled and twisted by mechanical action simulating rotatory rubbing between the hands ; this damages the cells, whereupon, possibly as a result of 'disorganized respiration', oxidase of the leaf brings about 'fermentation'. This so-called fermentation is mainly oxidation of polyphenols of the leaf to quinone compounds, which readily produce reddish, copper-coloured condensation products. The polyphenols of the leaf are the so-called tea tannins, but they are not tannins in the ordinary sense, as they are not able to convert hide into leather. The rate of 'fermentation' is highly important ; if too rapid, it gives inferior products, and the greater rate of fermentation, combined with lower quality of leaf grown in hot humid conditions, produces a commoner quality of tea. Indeed, the differences in quality and character between teas from different areas are due mainly to differences in geographical and climatic conditions, rather than to varietal differences in the plants grown. Changes in climatic conditions in the same area may produce much choicer tea at one time than a month earlier or later. It is the practice of blending, dependent on the remarkable skill of the tea taster, that enables the consumer to be supplied with brands of unchanging character. Most good teas, as supplied to the consumer, are blends of more than a dozen lots. Green tea is not subjected to 'fermentation', the enzyme activity being destroyed by heating the leaf (steaming) as soon as possible after plucking, after which the leaf is rolled and 'fired'.

Timber-drying Kilns

LEAFLET No. 30 (August 1943) issued by the Forest Products Research Laboratory, under the auspices of the Department of Scientific and Industrial Research, is on "Observations on the Design of Timber-drying Kilns". The leaflet, which does not pretend to deal in detail with design and construction, may be consulted for the information given on the size of kiln, double-stack pattern, single-stack patterns, heating systems, control instruments, and loading and unloading facilities. It is pointed out that in a well-designed timber-drying kiln provision must be made for (*a*) adequate and uniform air circulation between the rows of timber, (*b*) control of the humidity of the air, and (*c*) control of the air temperature. It is a generally accepted fact that except for a very limited type of drying operation, adequate air movement cannot be obtained except by means of fans, and that as a medium for heating and humidifying the air, steam can scarcely be rivalled. The practice of placing the heating elements and fans above the pile of timber is now fairly common in kiln design,

as this arrangement simplifies the construction and renders it unnecessary to excavate a basement. The propeller or axial-flow type of fan has also proved itself to be rather more adaptable generally to the requirements of timber kilns than has the blower or centrifugal type; the leaflet, therefore, is confined to the overhead-propeller fan types of kiln.

Micronesia and Melanesia

"Island Peoples of the Western Pacific, Micronesia and Melanesia" is the title of another volume in the series of War Background Studies published by the Smithsonian Institution. It is compiled by Herbert W. Krieger, ethnological curator, U.S. National Museum. The work is exactly what is required by anyone following the War in the Pacific at the present time. The Caroline Islands, the Gilbert Islands, the Marshall Islands, Bougainville and the Solomons, New Britain and New Ireland are all mentioned. To begin with, there is a general account of the region and its discovery and early history. This is followed by particular accounts of Micronesia and its islands, and similarly of Melanesia. The description of the native peoples and their customs will prove particularly interesting to many readers. There are throughout a large number of excellent illustrations.

Public Health in Colombia

THE April issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an interesting paper on this subject by Dr. Eduardo Santos, a former president of the Republic of Colombia. He states that in spite of adverse conditions 140 aqueducts, thirty sewers and twenty new hospitals have been constructed in the Republic in the past fifteen or twenty years. More than eight hundred institutions are now devoted to maternity and child welfare, and the prenatal services number at present 126 as compared with 62 in 1937. During this period hospital beds have been increased from 11,422 to 16,322, and forty-five hospitals with a total of 1,500 beds are now under construction. There are at present twenty-five tuberculosis dispensaries as compared with only four in 1937. The yellow-fever campaign is being carried on by the Government in collaboration with the Rockefeller Institute, which has an excellent laboratory at Bogotá devoted to the production of yellow fever vaccine. The campaign against typhus and bartonellosis is continuing. There is practical co-operation between the State and private agencies, such as the Red Cross, the Colombia Anti-Tuberculosis League, the Association for the Care of Lepers and other groups.

The Health of France

THE underground newspaper *Avenir Médical*, as quoted by *The Lancet* of February 12, gives the following account of the effects of food shortage in France. Adolescents are losing weight. Want of strength reduces the competence of adults for their work and favours accidents. Hypotension and anæmia are common. Bone decalcification and rickets are seen as in the regions invaded in 1914–18. 'War amenorrhœa' is prevalent in girls and young women. Famine œdema is becoming increasingly prevalent in private and hospital practice. Tuberculosis has risen by at least 20–30 per cent and assumes malignant forms which are rapidly fatal, especially in young people. Pregnant women being inadequately nourished bear underweight infants with a growing proportion of stillbirths.

Red Blood Cells as Wound Dressings

AN annotation in the *Lancet* (252, Feb. 19, 1944) directs attention to experiments by J. J. Moorhead and L. J. Unger (*Amer. J. Surgery*, 59, 104; 1943) on the application of pooled human erythrocytes, collected and stored aseptically, to wounds. The red cells form a gelatinous mass which dries over the wound, and it is claimed that sepsis subsides under this, while healthy granulations develop. T. H. Seldon and H. H. Young (*Proc. Mayo Clin.*, 18, 385; 1943) have experimented with a dried and powdered concentrate of red cells applied once or twice daily. In some cases this application smelt noticeably; in others it produced severe burning pain and was discontinued. In three cases it gave good results. These authors think that the method deserves further investigation and suggest that bovine erythrocytes might be tried.

An Astronomical Paradox

SCIENCE SERVICE has directed attention to an investigation by Dr. Otto Struve, director of Yerkes Observatory, of 48 Libræ, which "presents a notable paradox". This star reveals the characteristics of a super-giant and also of a main-sequence star. At wave-lengths longer than 3,650 A., a main-sequence *B*-type star is suggested; but at shorter wave-lengths the spectrum resembles a super-giant *A*-type star. During the last ten to twenty years, strong metallic absorption lines have developed. Some spectral lines arising in the gaseous shell surrounding the star are sharp and strong, while others are diffuse and weaker. On the whole, the observations indicate stratification in the tenuous shell surrounding the star. The outside layers are rotating slowly while the inner layers have a much higher speed of rotation, and at times they seem to be contracting and expanding. It is pointed out that there is a certain amount of resemblance between the shell surrounding this star and that observed in 1940 surrounding Pleione, but the peculiarities in 48 Libræ are more difficult to explain than they were in Pleione.

Announcements

PROF. W. H. PEARSALL, F.R.S., professor of botany in the University of Sheffield, has been appointed Quain professor of botany in University College, London.

MR. WALTER FITZGERALD, senior lecturer in geography in the University of Manchester, has been appointed professor of geography in the University in succession to Prof. H. J. Fleure, who retires next September.

DR. OTTO STRUVE, director of the Yerkes and the McDonald Observatories, has been awarded the Gold Medal of the Royal Astronomical Society for his work on the observation and interpretation of the spectra of stars and nebulæ.

PROF. C. H. BEST, professor of physiology in the University of Toronto, and Mr. T. Whittemore, archæologist, have been elected members of the Athenæum under the rule for special elections.

AT the annual general meeting of the Society of Public Analysts and Other Analytical Chemists, held on March 1, the following officers were elected: *President:* Mr. S. Ernest Melling; *Hon. Treasurer:* Mr. George Taylor; *Hon. Secretary:* Mr. Lewis Eynon.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Ground and Cloud Scatter of Electromagnetic Radiation

In former communications, the scattered echoes observed with high-power pulses have been described[1,2]. On a frequency above the vertical-incidence critical frequency there are normally short-lived echoes produced by direct scatter from ionic clouds in region E, and a patch of long-delayed diffuse echoes which has been assumed to be produced by energy which has been reflected obliquely from region F and scattered on its way down to the ground.

Although the rapid reduction in amplitude with increase of frequency suggests that the long-distance scatter is produced by the clouds in region E, it has been difficult to prove that the scatter is not, in fact, at the ground. Using the known theory of oblique transmission, it is possible to calculate the shortest possible delay-time from the $h'f$ curve on either assumption as to the origin of scatter. The difference is not large, but recent experiments in which both have been simultaneously observed have definitely shown that cloud-scatter is responsible.

The first experiments were made using a fixed frequency of 8·8 Mc./s. A typical record of the observed variation of delay-time (in units of kilometres of equivalent height) is shown in Fig. 1, together with the calculated values.

It has since been made possible to vary the frequency of the transmitter, so that the equivalent of an $h'f$ curve is possible. A typical example is shown in Fig. 2.

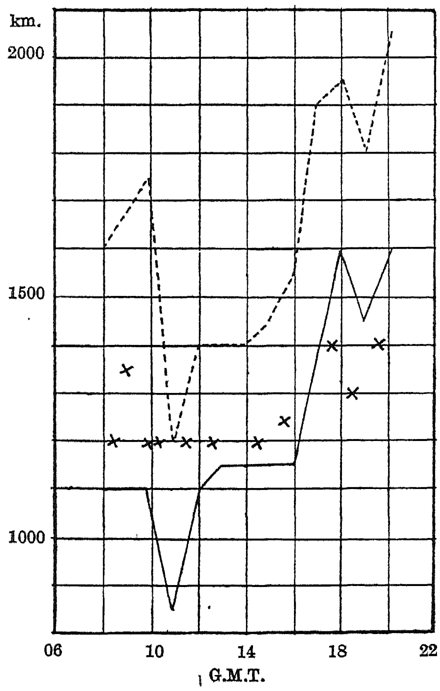


Fig. 1. Scatter delay on 8·8 Mc./s., Oct. 3, 1943. ×, Observed scatter delays; —, calculated delay for cloud scatter; - - -, calculated delay for ground scatter.

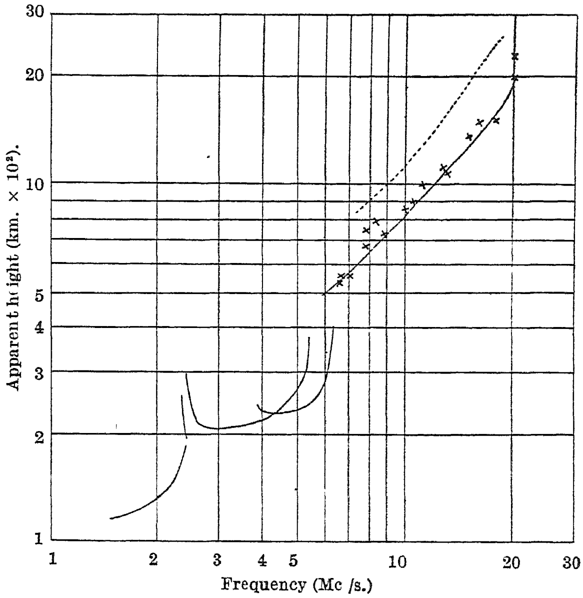


Fig. 2. Scatter $h'f$ curve, 1110–1123 G.M.T., Jan. 4, 1944. ×, Observed scatter delays; —, calculated delay for cloud scatter; - - -, calculated delay for ground scatter.

It will be observed that in both cases the agreement with calculated values shows that the scatter is in fact from the ionic clouds, and the original theory is entirely vindicated. It is not proved that ground-scatter does not exist, because it would be mixed in with the cloud-scatter from lower-angle transmission; but the fact that there is no noticeable increase of amplitude at the delay corresponding to the ground-scatter shows that the cloud-scatter is predominant. The cloud-scatter will be less at higher frequencies, so that eventually the ground-scatter will predominate; but this is not likely to be the case until frequencies greater than about 30 Mc./s. are used, where ionic scatter becomes unimportant because of the lack of F-region transmission.

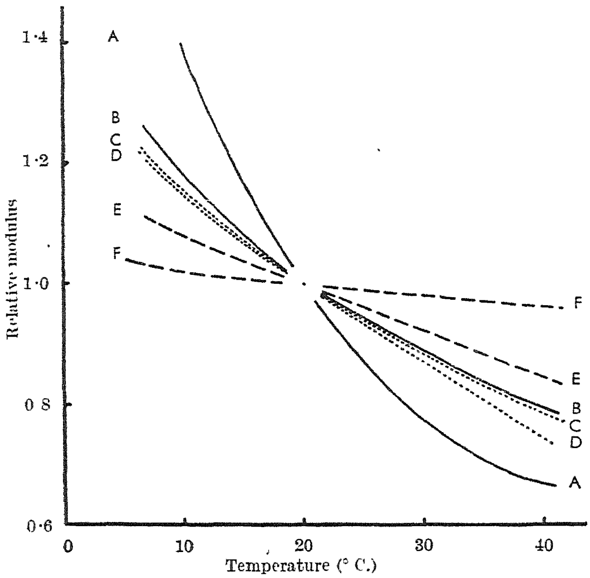
T. L. Eckersley.
G. Millington.
J. W. Cox.

Marconi's Wireless Telegraph Co., Ltd.,
Electra House,
London, W.C.2.
Feb. 11.

[1] Eckersley, T. L., Nature, 143, 33 (1939).
[2] Eckersley, T. L., *J. Inst. Elect. Eng.*, 86, 658 (1940).

Effect of Temperature upon the Mechanical Properties of Rubber-like Materials

In the course of investigations into the mechanical properties of natural and synthetic rubber intended for use in anti-vibration devices, variations of a large order were encountered. As these variations seemed largely dependent upon temperature, a preliminary detailed examination in the region of 5–40° C. has been made. Using a mechanical vibrator somewhat similar to that employed by Gehman[1] and working at 20–60 c.p.s., measurements of dynamic elastic compression modulus and associated resilience were made by the well-known resonance method. A



detailed description of the apparatus, method and results is to be published later, for the present it may be said that the test pieces were in the form of cylindrical rubber blocks $\frac{7}{8}$ in. in diameter and $\frac{7}{8}$ in. high, bonded at each end to steel screws by the conventional brass-plate method.

The property of an elastic material which is of paramount importance in determining its use as a vibration insulator is the dynamic modulus (in compression and/or shear). In order to compare the temperature variation of a wide range of materials from very soft to very hard, a plot may be made against temperature of relative modulus, that is, modulus at the stated temperature divided by modulus at some standard temperature (20° C. in the present case). Some early results are illustrated by the accompanying curves. The area enclosed by the full lines A and B shows the variation of the modulus-temperature effect in a comprehensive series of 'Neoprene E' (chloroprene polymer) compounds, the dotted lines C and D show the effect for a range of *GR–S* (butadiene-styrene co-polymer) compounds, and finally the broken lines E and F show the effect for a series of natural rubber compounds analogous to those in *GR–S*.

The purpose of this note is to direct attention to the following facts in connexion with rubber-like materials intended for use in anti-vibration devices.

(1) The dynamic modulus has a considerable temperature coefficient.

(2) Quite apart from temperature variations likely to be encountered in service, this fact is of importance in the quoting of dynamic results. The temperature of test should always be stated.

(3) No sign of a temperature effect of this order is evident from static loading tests; in the present work these were carried out using a well-known torsion flexibility measurement.

(4) In view of these facts, the practice of specifying the low-temperature requirements of such products as instrument mountings (anti-vibration) in terms of a static test is likely to lead to wastage of valuable raw materials and labour in the production of articles quite unsuitable for their intended purpose.

Similar results have been reported by previous workers[2], but it is felt that a considerably wider appreciation of such facts would be of general benefit in the present emergency.

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Surface Flow of Liquid Helium II and Bose-Einstein Degeneracy

Recently, London[1] has revived the theory of Bose-Einstein condensation and has discussed its application to explain some of the peculiar properties of liquid helium II. A most striking property of liquid helium II is the transport of the liquid over surfaces in the form of mobile films (thickness about 50 mμ) and, as is well known, it is because of the surface transport that the rate of flow of liquid helium II in very narrow channels (less than 10^{-3} cm.) is practically independent of the pressure head.

If v is the volume transferred per second per cm. width of surface, then the values of v for different temperatures, as observed by Daunt and Mendelssohn[2], are given below.

T_0 = λ-point = 2·19° K. $C = \dfrac{v}{1-(T/T_0)^{3/2}}$

$T°$ K.	1	1·5	1 7	1·9	2 1	2 16
$v \times 10^5$ (c.c. per sec.)	7·4	7·5	6·3	4·0	1·2	0
$C \times 10^5$	10·7	17·3	19·9	20 9	19·7	0

It is interesting to observe that for a Bose-Einstein degenerate gas, a flow independent of pressure is realizable, this being due to the flow of the particles constituting the condensed phase (non-energetic particles). The number of particles per unit volume in the condensed phase at temperature $T°$ K. is given by

$$n^* = n[1 - (T/T_0)^{3/2}], \quad . \quad . \quad . \quad (1)$$

where n is the total number of particles per unit volume and T_0 is the λ-point (= 2·19° K.).

If l denotes the thickness of the surface film, then the velocity of the particles in the condensed phase will be $u \sim h/2ml$, m being the mass of the atom. The volume rate of flow per unit width of the film will therefore be given by

$$v \sim \frac{n^*}{n}\frac{ul}{4} = \frac{h}{8m}[1 - (T/T_0)^{3/2}] \quad . \quad . \quad (2)$$

As the accompanying table shows, this relation, so far as the temperature dependence is concerned, agrees reasonably well with observation (the discrepancy is rather serious for the value at 1° K.). Further, the mean observed value of C is about 18, which may be compared with the theoretical value of 12·5 given by equation 2. This agreement appears to be indeed remarkable but, considering the crude nature of the theory, it is to be regarded as more or less accidental.

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Effect of Carbon Dioxide and Carbon Dioxide Fixation in Baker's Yeast

DETERMINATIONS of the amount of bound carbon dioxide in yeast cells under known carbon dioxide pressure in the gaseous phase were performed by me originally in order to investigate possible pH changes in the cells under different physiological conditions. This presupposes that carbon dioxide is bound in yeast chiefly as bicarbonate, which, however, according to the experiments described below, is probably not the case. In view of the importance of carbon dioxide in the metabolism of various cells, as pointed out by several workers, and in pursuance of earlier investigations on the physiology of baker's yeast, I have studied the influence of carbon dioxide on yeast metabolism.

The experimental material was fresh, compressed baker's yeast (dry weight c. 26 per cent) suspended in a $M/15$ sodium succinate buffer, pH 5·1 ; temperature 25° C.

The endogenous metabolism of yeast determined manometrically by means of the Warburg two-vessel method[1], as well as its uptake of glucose in the presence and in the absence of ammonium chloride, and, finally, the uptake of pyruvic acid, were found to be markedly higher under constant oxygen pressure and addition of up to 50 per cent carbon dioxide to the gaseous phase than in the controls in a mixture of oxygen and nitrogen. Anaerobically, however, the presence of 25 per cent carbon dioxide did not influence the uptake of glucose. The growth of yeast is markedly inhibited when the gaseous phase contains 50 per cent oxygen and 15–50 per cent carbon dioxide. During the endogenous aerobic metabolism, increased in the presence of carbon dioxide, the 'free' phosphate of the plasma, soluble in trichloroacetic acid, and the amount of orthophosphate passing to the outer solution (cf. ref. 2) were reduced. Anaerobically, carbon dioxide did not affect the amount of 'free' phosphate compared with controls. The experiments show the effect of carbon dioxide on the metabolism of yeast. Moderate concentrations of carbon dioxide in the gaseous phase, however, do not directly injure the cells.

Determinations of bound carbon dioxide in yeast were performed manometrically in trough-shaped Warburg vessels. The main compartment contained 1·50 ml. yeast suspension with 200 mgm. fresh yeast in $M/15$ succinate buffer, the side arms 0·30 ml. of 3·64 M p-toluenesulphonic acid. $\alpha^{20°}_{CO_2}$ of the mixture after tilting was found to be 0·728. Sulphuric, metaphosphoric, orthophosphoric and certain other acids proved to be useless for the fixation of yeast.

Bound carbon dioxide in yeast shaken in a gas mixture without addition of carbon dioxide is very low. For *baker's yeast*, the mean value of the measurements in nitrogen was 25 μl. ; for *starved yeast*, that is, yeast shaken aerobically for about 20 hours, it was c. 15 μl., and for yeast which, directly before the measurements, metabolized glucose aerobically for 2½ hours and which was washed (*fed yeast*), it was 40 μl. Finally, for yeast fed with glucose and ammonium chloride, by which procedure an incipient budding is attained (*budding yeast*), it was found to be 50 μl. carbon dioxide per gm. yeast. In a gaseous phase with 50 per cent oxygen plus 50 per cent nitrogen the respective values were 40, 20, 70 and c. 150 μl. carbon dioxide per gm. yeast. The bound carbon dioxide is markedly greater aerobically than

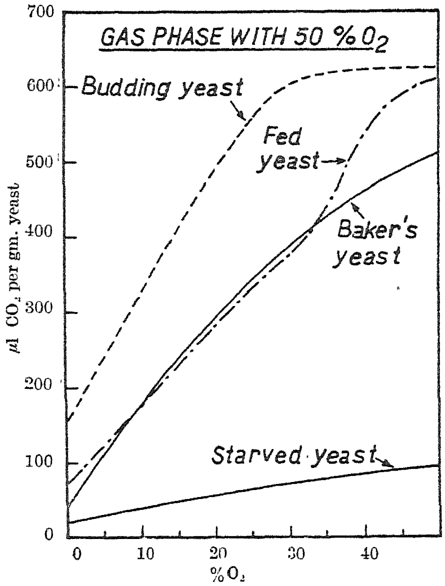

FIG 1.

anaerobically, and it is dependent upon the endogenous metabolism and the thereby conditioned carbon dioxide pressure in the cell.

Fig. 1 shows the bound carbon dioxide of corresponding yeasts in a gaseous phase with an excess of oxygen (50 per cent oxygen) and varying amounts of carbon dioxide. Fig. 2 exhibits bound carbon dioxide at constant carbon dioxide pressure and increasing oxygen pressure. The curves are drawn from the mean values of a great number of determinations. As a consequence of changes in α_{CO_2} during mixing, carbon dioxide is developed in an atmosphere rich in carbon dioxide. Corrections for blank values at different carbon dioxide pressures were made.

The portion of the bound carbon dioxide dependent on the oxygen pressure is bound reversibly and mainly conditioned by the physiological state of the yeast. It is not influenced by illumination with visible light. In experiments on yeasts treated in advance with hydrogen sulphide, cysteine, cyanide, azide or iodoacetate, there was found under aerobic

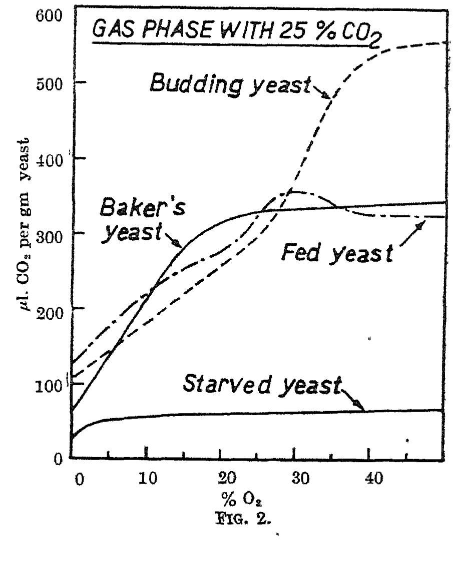

FIG. 2.

conditions a markedly less amount of bound carbon dioxide, similar to that of starved yeast. This indicates that the binding dependent on oxygen pressure is intimately connected with the oxidation-reduction processes in the cell. Brewer's bottom yeast showed a behaviour similar to that of starved yeast.

Calculations of *p*H from the maximum values of bound carbon dioxide, considered as bicarbonate, show that the *p*H in the cells in the presence of carbon dioxide must be increased up to *c.* 0·75 *p*H units above that assumed under anaerobic conditions and the same carbon dioxide pressure (25 per cent carbon dioxide). Such a great change in *p*H has not been verified experimentally. Electrometric titrations (glass electrode) were performed on juice from yeast, fixed rapidly by heating. The determinations indicate that in cells pretreated aerobically with carbon dioxide, this is bound in such a way that a decrease in *p*H is prevented. Under anaerobic conditions, however, this is not the case. Fife and Frampton[3] state that in plant material under the influence of carbon dioxide, ammonia will be liberated from acid amides and the *p*H will thus increase. Where yeast is concerned, I have not been able to confirm this, as the amount of ammonia liberated in the yeast was found to be extremely small, although the juice from yeast cells, pretreated aerobically with carbon dioxide, shows an increase in *p*H measured in absence of carbon dioxide in the atmosphere. Nor is it probable that carbon dioxide would be bound as carbamate (*R*.NH.COOH) at the *p*H in question.

The observations recorded here appear to have some connexion with the investigations performed on different material by Ruben and collaborators with radioactive carbon. Recently, Ruben and Kamen[4] have shown that baker's yeast can assimilate carbon dioxide (at present, the original paper is not accessible in Sweden). It appears probable that the carbon dioxide fixation described above might be interpreted as the first stage in the uptake of carbon dioxide and its further 'assimilation' in the yeast cells, corresponding to the dark reaction described by Ruben's school in connexion with experiments on photosynthesis.

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Relation of Scurvy to Histological Changes in the Pancreas

I HAVE shown[1] that the insulin content of the pancreas is markedly diminished in scurvy. In the present investigation attempts have been made to study the histological changes in the pancreas of scorbutic guinea pigs.

Two groups of healthy guinea pigs of weights varying between 163 gm. and 420 gm. were used. One of the groups was placed on a scorbutic diet for 24 days and the other was given normal diet for 15 days[1]. The animals were fasted overnight and killed next morning by a blow on the head. A portion from the tail end of the pancreas was fixed in Zenker-formol solution. Paraffin sections, 7 μ thick, were prepared, and these were stained with Heidenhain's iron hæmatoxylin and Heidenhain's 'azan' stains. In every fourth section from the tail end of each pancreas, stained with iron hæmatoxylin, the number of islets was counted and the size of the individual islets was measured. The results are summarized in Table 1 and the statistical analysis of the individual figures is given in Table 2.

PHOTOMICROGRAPH OF A SECTION OF GUINEA PIG PANCREAS; (*a*) NORMAL; (*b*) SCORBUTIC. × 80.

TABLE 1.

	No. of animals	Number (mean) of the islets in each section	Total (mean) size of the islets in each section (sq. mm.)
Normal guinea pigs	10	7·6	273·52
Scorbutic guinea pigs	10	11·2	1168·25

TABLE 2.

	Size of islets	No. of islets
Difference of the means	894·7	3·6
Standard error of difference	289·16	1·7
t	3·09	2·1
Remarks	Highly significant	Significant

The sections which were stained with 'azan' stain were examined for the different types of cells present in the islets of Langerhans. In the scorbutic guinea pigs, α-cells were found to be increased in number in proportion to the β-cells, and the β-cells were found to be mostly degranulated. There was no degenerative change in the sections studied. Photomicrographs show that the islets are very prominent in the scorbutic condition.

The increase in the size and also the number of islets may be due to Nature's attempt to react against the fall in insulin secretion observed in scurvy. The

absence of any degenerative change seems to be related to the fact that normal recovery takes place when the scorbutic guinea pigs are given supplements of vitamin C.

I wish to express my thanks to Dr. B. B. Sarkar and Mr. P. B. Sen of the Department of Physiology, University of Calcutta, for their kind help.

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Growth-Inhibiting Action of Some Pure Substances

THIS preliminary report describes the results obtained with a certain class of growth-inhibitors. Since evidence exists that *H*11 extract contains certain chemical compounds, it was decided to ascertain the inhibitory effects of some pure related substances upon the growth of the Twort carcinoma.

Tumour-bearing mice, averaging 25 gm. weight, were injected intraperitoneally, twice daily, with 0·5 c.c. of the solution to be tested. The surface areas of the tumours were calculated as the products of their diameters, and the group average determined. The inhibitory effect was calculated as the percentage difference between the average increases in size of the treated and the control mice.

Typical results obtained in comparable experiments are summarized in the accompanying table. Mice injected with certain chemicals, for example, anthraquinone, rapidly increased in weight during the course of the experiments, whereas the tumours were inhibited. Tests of substances toxic at higher concentrations, for example, the tannates, showed that, at lower concentrations, tumours were significantly inhibited, the host mice appearing completely unaffected.

Substance tested	Concentration (per cent)	Days of treatment	Percentage inhibition
Sodium tannate	0 25	28	83·3
Calcium tannate	Sat. soln.	8	51·3
1 : 2 : 4-trihydroxy anthraquinone	0·25	14	55 03
1 : 2 : 4 : 5 : 6 : 8-hexahydroxy anthraquinone	0·25	14	81 3
Anthraquinone	0·1	13	46·9
1 : 2-dihydroxy-5 : 8-naphthaquinone	0·25	14	90·6
henanthraquinone	0·1	8	52·1

Badger *et al.*[1] found that some quinone derivatives of carcinogenic hydrocarbons inhibited the growth of the Walker carcinoma 256, and Berenblum and Schoental[2] came to similar conclusions. Other phenolic, aldehyde and quinone derivatives of cyclic hydrocarbons have been tested; the results will be described later.

All these compounds have the property of combining with proteins. Derivatives of vegetable tannins react with proteins because of their polyphenolic constitution, and quinone compounds through their characteristic radicals. The inhibitory effects of these otherwise dissimilar substances are probably directly due to this reaction. A much greater inhibition of tumour-growth than of body-growth was produced. This greater susceptibility to the action of the inhibitors shown by the malignant cells must presumably reside in their intrinsic differences.

Such differences may be accounted for by a provisional hypothesis concerning a modification of cytoplasmic organization in tumour cells. Needham[3] has discussed the organization and differentiation of cells in terms of a cytoskeleton composed of protein fibrils. Wrinch[4] holds a similar view. The hypothesis is that, in the malignant cell, the cytoskeletal components have lost the power of linking up with one another to form a three-dimensional lattice such as may exist in a normal cell.

Fully differentiated cells are unable to divide, but the 'disarticulated' cytoskeleton of a malignant cell, while providing the morphological basis of dedifferentiation, would not hinder division. As the abnormal fibrils would presumably lose the power of responding to the evocator substances which control differentiation, malignant cells would remain undifferentiated and show unregulated growth.

Mottram[5] holds that malignancy results from cytoplasmic modification. The morphological differences between the cytoplasm of malignant and normal cells described by many workers are reviewed by Ludford[6]. The 'disarticulation' of cytoskeletal fibrils would result in such differences. The similarities between malignant cells and embryonic cells might also be explained in terms of the organization of the cytoskeleton.

On the cytoskeletal hypothesis, the various carcinogenic agents would induce malignancy by directly or indirectly modifying the cytoskeletal fibrils so that they no longer link up with one another. The premalignant period would be occupied by the accumulation of abnormal fibrils until their predominance prevents the formation of a normal 'articulated' cytoskeleton.

The mode of action of inhibitors with the property of tanning proteins would be to link up the discrete fibrils of a tumour cell to form a 'pseudo-cytoskeleton'; treated malignant cells would then become stabilized, 'non-malignant' cells, and would be much less able to reproduce themselves, with the result that the whole tumour would tend to regress. This effect of tanning agents on adult, healthy cells with normal cytoskeletons would be relatively insignificant. There may be a similar effect on the mitotic spindle and nucleus.

The cytoskeletal hypothesis furnishes a possible explanation of the site of action of tumour inhibitors which tan proteins and also of various phenomena associated with malignancy.

I am greatly indebted to Mr. J. H. Thompson, director of research of these Laboratories, for constant help and encouragement. My thanks are also due to Mr. C. R. B. Williamson for valuable technical assistance.

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Behavioural Changes in Spayed Female Guinea Pigs after Stilbœstrol Administration

In a recent assay of the œstrogenic potency of stilbœstrol, the results of which will be published elsewhere, interesting behavioural changes were observed in our animals.

Altogether 25 spayed female guinea pigs were treated with subcutaneous injections of small priming doses (0·0005–0·0025 mgm.) of stilbœstrol for 6–10 days, and at the disappearance of the vaginal closing membrane this treatment was followed by massive doses (0·5–1·0 mgm.) of stilbœstrol for 2–5 days. Furthermore, five animals, 3–4 hours after the last massive dose of stilbœstrol, received a subcutaneous injection of 0·2 mgm. of proluton.

Within a few days of the commencement of treatment, and while still receiving only small priming doses of stilbœstrol, all our animals became extremely quarrelsome. Cage-mates previously living in peace and amity became pugnacious and bellicose, as shown in frequent fighting during which fairly severe injuries were inflicted, including lacerated wounds in the mid-dorsal region. Finally, it was necessary to house the animals separately during the whole period of the experiment.

There seems little doubt that this unusual and totally unexpected ferocity among the female of the species was a sequel to the administration of stilbœstrol, which induced in our animals a masculine aggression—a component of the male sex-drive.

It appears, however, that the male behaviour such as the mounting activity described by Young and Rundlett[1] is a regular feature of the heat response of the female of many species in which it is integrated into the pattern reaction of a normal *libido*. The androgynous complex has been described in the female guinea pig[2], female rabbit[3], female rat[4,5], the sow[6], the cow[7] and the ewe[8].

Young, Dempsey, Hagquist and Boling[2] relate mounting activity in the female guinea pig to the synergizing action of the œstrin and progesterone of the mature follicles, and this is supported by the findings of Young and Rundlett[1], who produced mounting activity in spayed female guinea pigs by injections of œstradiol benzoate followed by progesterone.

The extension of the male effector responses into the domain of overt sexual behaviour in females seems to indicate that there is some common denominator in the psychic urge motivating the male and the female response, and that the subjective and objective manifestations of the sex drive need not exist as clear-cut sexual differentials but, as in the guinea pig, there may be a certain overlap—the production of a specific hormonal complex.

It is therefore perhaps not altogether surprising that some slight deviation from the normal stimulus such as might be produced by the difference in chemical structure of stilbœstrol and the natural œstrogens should be reflected in the exhibition of masculine aggression. In other respects (copulatory response[9,10], mounting activity, and all the vaginal and uterine preparations) the œstrogenic response of stilbœstrol is normal and complete. This invites the hypothesis that the study of behaviour offers a delicate test of hormonal balance, and is a plea not to neglect altogether the reactions of the higher neurones in any biological assay of the internal secretions of sex.

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Counterpart of the Davidson Current

During the period of upwelling in the California Current, it has been said that the California and the Humboldt (or Peru) Currents, on opposite sides of the equator, are "mirror images" of each other[1] (p. 204). Since upwelling is almost a constant process in the Humboldt Current, the similarity disappears when upwelling ceases in the more northern current during late summer, and is not noticeable until upwelling starts again the following March.

Each current has a subsurface counter-current of equatorial subsurface water flowing at approximately 200 metres below the surface. The factor preventing the rise of the subsurface current to the surface in the California Current appears to be upwelling, for, when upwelling ends, the subsurface current rises to the surface and also continues to flow in subsurface levels. Therefore, along the coast of California, from approximately November to January, there is equatorial subsurface water flowing northward from the surface to the shallow sea bottom within the narrow limits of the coastal counter-current.

This inshore, northward-moving, winter current along the California coast was discovered by George Davidson, in charge of the first U.S. Coast and Geodetic Survey of the West Coast, and was named after him. Parenthetically, it is worth remembering that Davidson, who was a scholar as well as a surveyor, wrote the first "U.S. Pacific Coast Pilot". At the outset, it was published by a San Francisco newspaper, because Davidson had difficulty in persuading the Government to print the material since it was undertaken outside his regular duties. He began gathering and writing the first "Pilot" in 1850; the Government publication was in 1858. The book was so helpful to shipping that the demand brought three editions within the next eleven years. In 1880, Davidson was commissioned to revise the "Pilot" again. Evidently he was at last afforded sufficient time to carry out his desires, for, in the nine years that followed, he prepared the monumental contribution, which has not been superseded since its publication in 1889.

Sverdrup[1] (p. 79) states that, during upwelling, the surface waters of the Davidson Current are too disturbed to allow the rise of the subsurface current to the surface. Certain it is, that only when upwelling

ceases or tends to cease does the Davidson Current exist as a surface current.

After reviewing the available data, I have come to the conclusion that a similar situation is maintained within the counter-current under the Humboldt Current.

In the southern winter of 1931, Gunther[2] (pp. 55, 129, 163) found the subsurface, return current at the surface twice—once at Antofagasta (23° 49′ S., 70° 36′ W.), and again at San Juan (15° 30′ S., 75° 12′ W.). Gunther attributed the rise in both instances to the unusually strong upwelling. His description of conditions at Antofagasta is too limited to admit of definite conclusions, for he states that the situation here is unusually changeable.

But at San Juan, the wind was blowing from the south-east—an inshore wind at this point on the coast. Inshore winds tend to terminate upwelling, according to both Schweigger and Gunther. At San Juan, the subsurface current was at the surface for a width of 60 miles, and was flowing against the wind with a strength sufficient to carry the survey ship backward when the wind had a Beaufort Scale force four. A little to the south, and also to the west and to the north, the subsurface current had dropped below the surface.

It seems likely that the inshore wind had caused the upwelling to cease sufficiently at San Juan to allow the subsurface current to rise to the surface, similar to the Davidson Current and for the same reason[3]. The only real difference is that the upwelling in 1931 had ceased only in the vicinity of San Juan; whereas, in winter, upwelling ends throughout the coastal flow of the California Current.

Schweigger[4] has shown that, when upwelling is strong, even large attempted invasions from the north and west of tropical waters into the Humboldt Current area are held back. The data of the International Petroleum Company, Ltd.[6], recorded at Ancon and La Libertad, Ecuador, and compiled during the strong upwelling of 1938 support the same conclusion.

In 1939, the period of weak upwelling, the warm waters succeeded in entering the Humboldt Current area. They did not appear in one compact, surface water mass, but in bands or strips largely separated from the coast and from each other, either by cooler bands, or by successively or alternately warmer strips out toward the open sea. At times, these warm water areas were entirely isolated by surrounding cooler water. At Pisco, the southward moving surface stream was a torrent; yet less than seven miles farther south, the normal cool waters of the Humboldt Current were at the surface[5].

In my opinion, such strips or bands indicate a rising to the surface of subsurface water due to temporary cessation or weakening of upwelling within the Humboldt Current, typical of the Davidson C[illegible]rent. If this apparent tendency proves to be cor[illegible] to Gunther's suggested explanation of strong [illegible]welling, the cessation of upwelling may be added as a possible cause for the rise to the surface of the subsurface current. If oceanographic data concerning low oxygen content in the subsurface waters be demonstrated to be as low as that in the subsurface waters of the east Pacific equatorial regions[1,7], this would offer another probable explanation for the occasional catastrophic death of the rich surface-water life in the Humboldt Current, and also another possible explanation for the appearance in these coastal waters of the mysterious recurrence of hydrogen sulphide, which is locally known as the 'Callao Painter'.

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[7] Thomsen, Helge, Nature, 127, 489 (1931).

White Plumage of Sea-Birds

The interesting communication from Dr. K. J. W. Craik in Nature of March 4 has inspired me to look up my correspondence with the Government on the subject of war camouflage during the War of 1914–18, and I find, according to the official copies obtained through the Royal Commission on Awards to Inventors, that the letter laying down the principles now popularly known by Thayer's terms 'Counter-shading' and 'Dazzle' was addressed to the then First Lord (Mr. Winston Churchill) on September 24, 1914, and that which laid down the principle that the underside of opaque aircraft should be coloured 'brilliant white' was addressed to the then Secretary of State for War (Mr. D. Lloyd-George) and dated September 28, 1916.

Since these early days, I have had various entertaining encounters with camouflage artists—not to mention high Government officials—who held white to be the most conspicuous, instead of the least conspicuous, colour against a background of sea or sky, except, of course, under special conditions such as at sea when viewed from a high angle, or in the air when viewed against a dark sky or when banking and illuminated on the underside by the sun at a low altitude.

The utility of the white undersurface of aquatic birds and fish in reducing their conspicuousness as viewed from below by their potential prey is, of course, recognized by all field naturalists.

John Graham Kerr.

House of Commons.

An Early Swanscombe Skull

In all accounts and discussions which I have seen of the important fossil cranial remains found at Swanscombe in June 1935 and March 1936, there is no mention of an earlier discovery of more complete human skeletal remains made in the same locality some time prior to 1913. A few hours before this present note was written, I stumbled across the reference to this earlier Swanscombe skull. This reference is contained in a footnote to an article written by Dr. W. L. H. Duckworth[1].

It would be of great interest to know where these human skeletal remains are now to be found. It is to be hoped that this communication will lead to the location of these remains and to a full report on their history and character.

M. F. Ashley Montagu.

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Hahnemann Medical College and Hospital,
Philadelphia, Pennsylvania.

[1] "The Problem of the Galley Hill Skeleton", in "Essays and Studies Presented to William Ridgeway" (Cambridge: At the University Press, 1913), 460.

THE SYCAMORE TREE

By ALEXANDER L. HOWARD

IN company with many other prosperous exotics, the so-called 'sycamore' has lived for many generations in Great Britain under a false name. Sycamore is an attractive name, but as applied to this tree it is both incorrect and misleading: the term *Acer pseudoplatanus* is equally so. The word 'sycamore', spelt by the early botanists 'sycomore', is the name for a fig tree, very well described by Pliny, 69–115 A.D. The botanical term *Acer pseudoplatanus* is inaccurate, as in no respect can the sycamore be considered a spurious or, in modern phraseology, *ersatz* tree. The only excuse which can be put forward is that the leaf resembles the plane in its shade of green, and also in its shape. If this reason be sufficient, then most certainly the botanical name for the wych elm should be *Ulmus pseudo-corylus*, since the resemblance between the leaf of the wych elm and that of the hazel (*Corylus avellana*) is greater. Four authorities of very different dates all bear witness to this long-standing mistake.

Pliny says:

"In Aegypt likewise there be found many trees which grow not elsewhere: and principally the Sycomore, which thereupon is called the Aegyptian Figtree. The tree for leafe, bignesse, and barke, is like unto the Mulberie tree. It beareth fruit not upon the branches, but out of the very body of the stocke. And the same is a passing sweet fig, but without any graines at all within. It doth increase in exceeding great abundance."

John Evelyn (1664):

"The Sycamore or Wild Figtree falsely so-called, is our *Acer Magus* or Broad-leaved *Mas*, one of the Maples."

Students of the New Testament remain under the impression that the tree into which Zaccheus climbed to see Christ pass on his way to Jerusalem was the sycamore as we know it, whereas it was in fact the *Ficus Sycamorus*—the fig mulberry. Even Jacob S. Strutt in his "Sylva Britannica" falls into this error.

William Boutcher, nurseryman, in 1776, writes:

"The greater Maple, in England *falsely* called the Sycamore and in Scotland the Plane tree."

Whether the term 'broad-leaved maple' as in America, the botanical name *Acer macrophyllum*, or *A. Magus*, or any other scientific name should be applied, matters not, but the tree should certainly not be called sycamore or *Acer pseudoplatanus*. In bark, twig, leaf, fruit, and flower, and more particularly in wood, there is no kind of resemblance between the so-called sycamore (English) and the plane. Both trees produce valuable and useful wood, but they are not suitable for similar purposes. Whereas the sycamore is not indigenous to Great Britain, its close relative—the small-leaved or old-English maple—belongs here, as will be seen later. Although the introduction of the sycamore to southern Europe may have occurred at an early date, Pliny does not mention it. The earliest known record is about the fourteenth century, when, according to the Rev. C. A. Johns, Chaucer speaks of it as "a rare exotic".

Elwes quotes:

"Clement Reid hazards the suggestion that it was introduced by the Romans. Ray states, Synopsis 230, published in 1690, that the Sycamore was then planted in cemeteries and about the houses of the nobility, and that it was nowhere wild in England."

All records show that it did not receive a very warm welcome. To quote John Evelyn again:

"the Sycamore is much more in reputation for its shade than it deserves . . . for the honey-dew leaves, which fall early like those of the Ash turn to mucilage and noxious insects and putrify with the first moisture of the season, so as they contaminate and marr our walkes, and are therefore by my consent, to be banished from all curious gardens and avenues."

The Rev. C. A. Johns, and all other early writers, speak of it unkindly, but the sycamore, in spite of this unpopular reception, seems to have become well adapted to its new habitat, and full of life, vigour, and determined perseverance, and has now become established in Great Britain.

In youth it cannot be classed among the beautiful trees of our landscape, but in later age the case is different, and the fully matured sycamore is a noble tree holding its own among its neighbours. While it is certainly surpassed in beauty by its cousin, the small-leaved English maple (*Acer campestre*), it is now an outstanding feature of parks and public gardens, churchyards and stately mansions, where it attains a certain grandeur. The crown in the early spring is clothed with rich green leaves falling in graceful sprays, which later turn to a darker colour, reminiscent of the ebony in tropical regions. As autumn approaches, the small-leaved maple turns to a rich gold, while the sycamore still holds its sombre green, only broken by the appearance of black spot, against which precaution should be taken. While its life may be extended far beyond 150 years, it cannot be said to compare in this respect with our indigenous trees, and the forester should therefore realize that it should be harvested at an earlier age than others—perhaps not later than 80–100 years, after which time the quality of the tree deteriorates. "English Forests and Forest Trees", published in 1853, mentions as the largest known sycamore at that time the tree at Bishopston in Renfrewshire:

"which measured 60 feet in height and 20 feet in girth. This tree is known to have been planted before the Reformation, and is supposed to be not less than 300 years old, yet it has the appearance of being perfectly sound."

But Elwes in 1913 says:

"I think the palm must be awarded to a tree near the Marquess of Ripon's house at Studley Royal, Yorkshire. This tree is about 104 feet high, by 17½ feet in girth. It has a very large burr close to the ground, where it is 29½ feet round, and a clear bole of about 30 feet."

He also mentions another tree at Powerscourt, Co. Wicklow, which "is a fine wide-spreading tree 80 feet high by 14 feet in girth". When I saw this tree in 1936 it was an outstanding example of grace and beauty, and always attracted the attention of many who travelled far to see it.

When felled at its prime, the sycamore tree provides a wood of such exceptional value that for this purpose alone its continued prosperity should be assured. The colour of the wood is creamy white, and the grain close, compact, and capable of an ivory surface—whether straight-grained and plain or beautifully figured with mottle or broken roe and mottle, it is always attractive and comparable to the wood of the same tree which has been imported from Canada and America in considerable quantities. The timber from these sources can be mixed with our own home-grown products, so that they are indistinguishable. When the wood is stained with a

solution it is possible to produce a surface which is so universally admired that it has proved invaluable for decorative purposes such as panelling and interior decoration of houses, and furniture: this production is known as 'hare-wood'. Sycamore has been used for the making of a great number of domestic utensils and furniture in its unstained condition, and for many years has been greatly in demand for rollers for printing linen. In this connexion Elwes mistakenly assumes that the outstanding value of this wood is for these rollers. In actual fact, the great value of sycamore renders it far too costly for this purpose, as the strict selection for quality and waste in conversion, both essential for this work, can only result in a loss.

While its natural colour is not always improved by exposure to light and air, if it is used where continual scouring and cleaning is necessary, it is an admirable medium, and since the eighteenth century it has been much in demand for kitchen tables, counters and the like. The gangway for the admission of Royal personages to King Edward's steam yacht was, by his special command, constructed of sycamore, which by continual scrubbing kept its spotless white appearance.

The small-leaved English maple (*Acer campestre*), improperly called the 'common or field maple', deserves especial attention. Why the undignified term 'common' should have been applied to it is difficult to understand. The dictionary gives as the definition of 'common', "vulgar, mean, usual, and public", but the tree is none of these—there is nothing mean about it, and it is by no means common; in fact, to-day, whatever it may have been in the past, it is uncommon. It is one of the most beautiful trees which ornament the country, principally in parks and surrounding stately mansions. Throughout its life, whether in spring, summer, autumn or winter, it is a graceful feature of the landscape. Unadorned, its branches make a lovely pattern against the winter sky. In spring its tender pale green leaves present a pretty sight. In summer the spread of the foliage is different from all other forest trees; but its full glory is reached in the autumn when the leaves turn to ripe gold.

In the historical place at Cassiobury Park, Watford, the seat of the Earls of Essex, among a unique collection of oaks, chestnuts, beeches, elms and ash trees, there were two early English maples, equal in beauty to any of that noble company, and one of them, probably the best of its kind, was to be found thirty years ago. Its important uses do not seem to have been ever fully recognized. Its suitability for hedgerows has been almost entirely ignored: in such places quickthorn, privet, cypress, yew, ivy, beech, hornbeam and Japanese *Lonicera nitida* are commonly employed, whereas the maple has had to struggle on alone without encouragement. English arboriculturists do not seem to have appreciated either its beauty or its value for timber, which was not the case with those earlier enthusiasts whose writings have come down to posterity. The Rev. C. A. Johns quotes that "Virgil represents one of his kings as seated on a *Maple* throne", and Pliny says "the trunk for beauty and firmness of grain is inferior only to the Citron wood". It is curious to notice that from the time of Evelyn no one seems to have been interested in furthering the claims of this beautiful tree. The timber generally is little known to-day, although it possesses qualities which would have rendered it invaluable in place of wood which has been imported from other countries. In this category may be named American, Canadian, European, Swedish and Norwegian supplies—most of them unknown to the craftsmen of those earlier times, who depended upon their own home-grown timbers for the supply of domestic utensils made of wood. Indeed, the origin of the name 'mazer' for bowls and drinking cups signified the name of the wood from which they were made, the word 'mazer' being a corruption of the old Welsh word 'masarn'—the maple tree. Such bowls and drinking cups were in common and continual use, and were handed down from father to son as heirlooms.

Even ordinary observers will have noticed the habit which many trees exhibit of throwing out all round the trunk, sometimes at the base, sometimes at the crown, and sometimes in between, the growth of tiny branches massed together. This habit is most pronounced in the English or common maple, and is even more abundantly found in similar trees of other countries. Such examples are highly prized and eagerly sought for, and when cut on the rotary machine, round the tree in veneer, the wood yields a product named 'birds-eye' maple. This peculiar growth increases the value threefold and sometimes more.

The ivory-white colour and the quality of the grain of the small-leaved maple enable the craftsman to produce an article which will withstand continual washing and preserve an ornamental surface. While the grain is tough, it is not brittle, and the tool of the sculptor or engraver can work it with satisfactory results in every direction of its growth. As Pliny says, "it is in great request for many exquisite and sumptuous workes".

In the list of trees which the future forester should establish, planting them again and again, the so-called 'sycamore' and the 'common' English small-leaved maple should certainly receive a prominent place. The man who plants these trees will be repaid in full measure, and in a shorter period of time than in the case of most hardwood trees.

BUILDING RESEARCH IN THE UNITED STATES

THE report of the British Building Mission, appointed by the Minister of Works in July 1943, on building methods in the United States, which has now been published by the Ministry of Works (H.M. Stationery Office, 4*d*. net) contains, among much that is of general interest, a good deal of special interest to scientific workers. This is particularly true of the first part of the report, dealing with the design of buildings. The report points out that American designers, knowing that many buildings of no great age are threatened with obsolescence of equipment and general design, show a tendency to assume that, in view of the rapidity of scientific development and social change, future generations of Americans will demand to live and work in buildings evolved by themselves and appropriate to their own times; they appear to believe that many of the buildings of the present should be designed strictly for their immediate purpose, and that a limited life for a building may be an advantage rather than the reverse. American manufacturers are accordingly seeking to produce new materials fulfilling the general requirements of serviceable building but costing less

than traditional materials and not necessarily having the same length of life.

Early specimens of new materials for building construction were inspected by the members of the British Mission, who were informed that when in full production their cost would be substantially less than that of traditional materials. The importance of such developments with reference to the short-term planning of building in Great Britain to deal with the immediate problems of reconstruction in bombed areas needs no emphasis, while the observations on amenities in buildings are fully as relevant to a long-term building plan. The report mentions that the most noteworthy improvements in general amenities, particularly in housing, involved a considerable increase in the consumption of electricity, gas and water; thus the average consumption of water per head of population is more than double the British rate, while a number of plug-in socket outlets for electrical appliances is provided in every room.

A section in this first part of the report is devoted to research and information services. A considerable volume of scientific research is regularly undertaken by various interests including the Federal Government, universities, professional institutions, trade associations, materials manufacturers and organizations financed by private benefactors. The importance of research to American building is fully recognized by all concerned with the welfare of the industry. Large funds are expended, but while the Mission was impressed by the excellence and variety of the equipment in the research establishments visited, and the many channels of contact between research workers, there is no institution in the United States comparable with the Building Research Station in Britain, and greater co-ordination on a national scale is an admitted need. The keenest interest was expressed in many places in the work of this and other research stations of the Department of Scientific and Industrial Research; and British research concerned with the daylighting of schools and with the control of sound transmission in buildings is followed with special attention.

The large number of university-trained scientific workers employed in the American building and manufacturing industries, and the status of these workers, impressed the Mission, which considers that the efficiency of the industry in Britain would greatly benefit by the employment of more research workers and by the adoption of American methods of using scientific personnel. It is also suggested that existing provision for the exchange of scientific papers relating to building and constructional work generally between Government agencies in the United States and in Britain should be broadened, and that regular liaison should be established between the Ministry of Works and development and research organizations concerned with American building, including the National Bureau of Standards. The comparatively few personal contacts between research workers of the two countries appear to have been well worth while, and hopes are entertained of a regular exchange after the War.

In the United States, as in Great Britain, much of the research effort which would normally be directed to the improvement of building and building materials is now being expended in the war effort, and many advances are anticipated in the development of building materials, more particularly in plastics, non-ferrous metals, composite and temporary materials and materials used for thermal insulation. On the other hand, the Mission did not find many new materials in use, nor many new methods of using old materials. The more interesting materials are not yet in full commercial production. In particular, the application of plastics in building is at present inconsiderable. Some use has been made of extruded plastic pipes as an alternative to metal pipes, and the use of plastic sheets having a base of laminated paper or fabric for table tops, sinks, draining boards, etc., is expected to extend very rapidly after the War. The future of plastics in building, however, must depend on the cost of production.

Statistical research is of vital importance to the building industry, and this is well realized in the United States. Among the more outstanding work, the report mentions "The Study of Consumer Purchases", a social survey by the Bureau of Labour Statistics, which includes housing, furnishing and equipment; the Construction Section of the Census of Business, a national survey undertaken by the Department of Commerce in 1939; the regular bulletins on new building issued by the Bureau of Labour Statistics of the Department of Labour; the monthly bulletins of the same Bureau, giving details of labour conditions and trends; the analysis of new house building in selected areas published by the Federal Housing Administration; the annual report of that Administration, analysing building loans insured during the year; and the publications of the F. M. Dodge Corporation covering new building throughout the Eastern States and the Middle West.

Again, the Mission was impressed by the efficiency of American methods of disseminating the knowledge gained by research workers through trade publications and the daily Press, through wireless broadcasts, exhibitions and technical and scientific meetings and conferences. Materials manufacturers realize the importance of supplying architects and engineers with technical information about their products. The general excellence of the presentation of technical data is well exemplified in the information services of the Dodge Corporation of New York, while the small and medium-size instructional exhibition is regarded in the United States as one of the most useful and popular channels for spreading new information. The report suggests that this instrument should be fully used by the Ministry of Works and by the building and manufacturing industries in Great Britain.

One of the most impressive features of this exceptionally interesting report is, in fact, that it illustrates the soundness of many of the arguments advanced in Great Britain for extending the research effort and encouraging a wider utilization of science in industry.

Fuller use should be made of American experience with factory-produced houses, materials for soil stabilization, the moving of entire buildings, repair of damaged buildings by the cement-gun process, materials already in extensive use in the United States such as composite slabs and panels, asphalt floor tiles and pitch for flat roofing, and materials likely to be more widely used after the War, such as plastics and compositions making use of sawdust and other wood waste. In regard to investigations, those on installations and appliances for houses and flats, availability of public utility services, methods of thermal insulation, district heating and hot-water supply, abatement of noise in buildings, standardization of materials and components for quality and

performance and of dimensions of components and equipment and on artificial lighting of buildings, particularly of shops, museums and art galleries, should be pressed forward, while other investigations should be instituted into minimum standards of quality in house design and construction, and standardization generally.

Among the American practices adoption of which is recommended are simplification of design of buildings for greater standardization and for mechanization of constructional work, greater use of factory-produced units and assemblies, increased employment of scientific workers for industrial research in the factory and in the field, encouragement of operatives by spreading information concerning the job and by official recognition of good craftsmanship and greater use of plant machinery and hand-power tools. Finally, the report recommends that legislation be promoted with the object of securing registration of architects and of professional engineers, so that building plans shall be prepared by registered persons only.

SUB-ANTARCTIC AND ANTARCTIC POLYZOA

DR. HASTINGS' extensive monograph on part of the Polyzoa of the Discovery collections includes much careful and critical work*. The six families involved are the Scrupocellariidæ, Epistomiidæ, Farciminariidæ, Bicellariellidæ, Aeteidæ and Scrupariidæ. The last family is, however, included with the Cellularina merely for convenience, and it is not intended to imply that it certainly belongs to that group.

The most important part of the work is undoubtedly the distributional data. Recent hydrological investigations made by the Discovery expedition have been available throughout, and correlation of the distribution of the antarctic and sub-antarctic species with the hydrology gives suggestive results. Thus change of hydrological conditions at the Antarctic Convergence appears to have a decisive influence on the non-abyssal Polyzoa. The presence of species with antarctic affinities in a zone off the Patagonian shelf is probably influenced by antarctic waters, and the distribution of abyssal species is possibly related to warm and cold deep currents.

An interesting fact is the similarity of the polyzoon fauna of Heard Island to that of the other islands in the South Indian Ocean although the hydrological conditions are different. Deacon (1933) has shown that these islands of the South Indian Ocean are hydrologically on the borderland between the Sub-antarctic and the Antarctic Convergence, Heard Island being well to the south and clearly antarctic hydrologically, but there appear to be grounds for regarding the Cellularine polyzoa of the islands, including Heard Island, as sub-antarctic rather than antarctic. It may be pointed out, however, that while Heard Island is connected with Kerguelen Island to the north by a submarine ridge, it is separated from the nearest point on the Antarctic mainland by some eight hundred miles of deep sea, for the so-called Kerguelen-Gaussberg ridge, although it represents a considerable rise in the floor of the great basin south of the Indian Ocean, still shows depths of more than a thousand fathoms over most of its length. The Patagonian region, on the other hand, has a series of stepping-stones with the Antarctic provided by the islands of the south antillean arc. In considering the distribution of a group such as Polyzoa, which are sessile during a large part of their life-history, these facts may help to explain why a correlation with hydrological conditions apparent in one region does not work in the other.

The collection is rich in ancestrulæ (the ancestrula being the first zooecium of the colony formed by the metamorphosis of the larva). These are different from the rest of the colony and important from a systematic point of view. They are only known in a small proportion of the species and much new material is described here. It was thought that these might give evidence of the breeding seasons. Although only tentative, the facts assembled seem to show that the ancestrulæ are more frequently found in the early months of the year, although colonies were collected over a period of from four to seven months.

The report is very well illustrated both by numerous clear text figures and photographic plates.

* Polyzoa (Bryozoa) I. Scrupocellariidae, Epistomiidae, Farciminariidae, Bicellariellidae, Aeteidae, Scrupariidae. By Anna B. Hastings. Discovery Reports. Vol. 22. Pp. 301–510, plates v–xiii. Issued by the Discovery Committee, Colonial Office, London, on behalf of the Government of the Dependencies of the Falkland Islands. (Cambridge: At the University Press; 1943.) 9*d*. net.

THE GEOLOGY OF RHUM (INNER HEBRIDES)

AT the meeting of the Geological Society on January 19, Dr. E. B. Bailey presented some new facts and a revised interpretation of the igneous and tectonic geology of Rhum. A great dislocation described by Harker in 1903 as a Palæozoic thrust is now claimed as a Tertiary ring-fault with central uplift. Harker was influenced by the curvature of the outcrop of the fault, and by the slump-bedding of the Torridonian which he interpreted as a tectonic structure. He was also misled by a patch of Trias which he mistook for crushed Torridonian; by certain associated banded Lewisian gneisses which he regarded as banded Tertiary igneous rocks; and by a set of Tertiary explosion-breccias which he thought were crush-breccias developed by early Palæozoic thrusting. Bailey considers the outstanding tectonic feature of Rhum to be a block uplift, amounting locally to about 7,000 ft., which took place at the start of the Tertiary vulcanicity and was indirectly responsible for the inter-lava river gravels of the neighbouring island of Canna. The peridotites of Rhum were later than the block uplift; they rose along ring-fissures about a centre well to the west of that surrounded by the great initial ring-fault.

At the same meeting S. I. Tomkeieff described the petrology of the famous ultrabasic and basic plutonic rocks of the Island. The mineral compositions of the rocks and the order of crystallization have been accurately determined and it is shown that the ultrabasic rocks comprise a continuous peridotite-allivalite series which is assumed to have been formed by the crystallization of an already differentiated heterogeneous magma. How this differentiation took place remains the outstanding problem still to be solved. The basic rocks are mostly olivine-eucrites, locally strongly banded. A later boss of granophyre is found to be contaminated along its junction with the eucrite.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, March 18

INSTITUTE OF PHYSICS (INDUSTRIAL RADIOLOGY GROUP) (in Room 1, Chelsea Polytechnic, Manresa Road, Chelsea, London, S.W.3), at 2.30 p.m.—Open Discussion on Miscellaneous Questions on Industrial Radiology.

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Mr. W. J. Meredith and Dr. G. J. Neary: "The Production of Isodose Curves and the Calculation of Energy Absorption from Standard Depth Dose Data"; Mr. P. H. Flanders: "A Demonstration of an Optical Contour Finder".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 2.30 p.m.—Dr. H. M. Finniston and Mr. T. D. Fearnehough: "The Physical and Mechanical Properties of Segregates".

Monday, March 20

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. Franklin Kidd: "Dehydration of Foodstuffs" (Cantor Lectures, 1).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion of "Industry's Opportunity in Education" (to be opened by Dr. P. Dunsheath).

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (by invitation of the Nottingham Section), (at University College, Nottingham), at 6.45 p.m.—Mr. G. Loasby: "Nylon".

BRITISH ASSOCIATION OF CHEMISTS (TEESIDE SUB-SECTION) (in the Y.M.C.A. Rooms, Stockton), at 7 p.m.—Mr. A. Heron: "Micro-analysis".

Tuesday, March 21

BRITISH ECOLOGICAL SOCIETY (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 10.30 a.m.—Discussion on "The Ecology of Closely Related Species" (Speakers: Mr. D. Lack, Mr. C. Elton, Dr. G. E. Blackman, Capt. C. Diver, Mr. G. M. Spooner and Dr. G. C. Varley).

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. P. D. Mehta: "Tribes, and the Caste System of India".

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. J. R. Furlong and Mr. E. L. Hill: "Paper-making Materials of the British Empire".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Dr. Geoffrey Bourne: "The Problem of Bone Formation".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (at the University, Manchester), at 5 p.m.—Prof. H. W. Florey, F.R.S.: "Some Antibiotics with special reference to Penicillin".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, G.B.E., Pres.R.S.: "Chemical Factors in Nervous Effects", i. "Substances Imitating Nervous Effects—Adrenaline, Nicotine, Muscarine, Acetylcholine".*

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Treatment and Tests for Extreme Climatic Conditions" (to be opened by Mr. P. R. Coursey).

Wednesday, March 22

INSTITUTE OF FUEL (at the Engineers' Club, Albert Square, Manchester), at 2.30 p.m.—Mr. P. D. Kirkman: "The Use of Unfamiliar Fuel in Steam-Raising Plant".

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (joint meeting with the LONDON AND SOUTH-EASTERN COUNTIES' SECTION OF THE ROYAL INSTITUTE OF CHEMISTRY) (at the Royal Institution, Albemarle Street, London, W.1), at 2.30 p.m.—Dr. L. R. G. Treloar: "Rubber and the Rubber-like State".

Thursday, March 23

TOWN AND COUNTRY PLANNING ASSOCIATION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 12.45 p.m.—Luncheon preceding Annual Meeting; Rt. Hon. Sir Montague Barlow, Bart.: "National Planning and British Industry"; at 2.45 p.m.—Annual Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Dr. Geoffrey Bourne: "Vitamin C and the Regeneration of Bone".

Friday, March 24

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir Lawrence Bragg, F.R.S.: "Lightning Calculations with Light".*

INSTITUTION OF MECHANICAL ENGINEERS (in conjunction with the MANUFACTURE GROUP) (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. F. Kayser: "Surface Finish".

Saturday, March 25

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—"The Assessment of Lens Performance" (Mr. A. Cox: "General Theory of Lens Performance"; Mr. H. W. Martin: "Lens Types and their Characteristics").

BIOCHEMICAL SOCIETY (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 2.30 p.m.—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

PSYCHOLOGIST (full-time) for the Child Guidance Clinic—The Acting Director of Education, Becket Street, Derby (March 22).

SPEECH THERAPIST—The Director of Education, Education Offices, Woodlands Road, Middlesbrough (March 25).

SUPERINTENDENT OF THE METALLURGY DEPARTMENT—The Director, National Physical Laboratory, Teddington, Middx. (March 25)

DEPUTY BOROUGH ENGINEER AND SURVEYOR—The Town Clerk, Finsbury Town Hall, Rosebery Avenue, London, E.C.1 (endorsed 'Deputy Borough Engineer') (March 27)

TEACHER OF ENGINEERING SUBJECTS (in particular Engineering Science) at the Cambridgeshire Technical School—The Education Secretary, Shire Hall, Cambridge (March 27).

LECTURER IN THE MINING DEPARTMENT—The Principal, Technical College, Church Street, Barnsley (March 27).

LECTURER IN PSYCHOLOGY—The Principal, Froebel Institute, at Knebworth House, Knebworth, Herts (March 28).

LECTURER (full-time) IN THE DEPARTMENT OF BUILDING of the Leeds College of Technology—The Director of Education, Education Offices, Leeds 1 (March 28).

DEMONSTRATOR IN CHEMISTRY—The Dean, Guy's Hospital Medical School, St. Thomas's Street, London, S.E.1 (March 31).

METALLURGIST (well-qualified) to take charge of Research and General Laboratories, Heat Treatment, etc., Sheffield Steel Works—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2048.XA) (March 31).

PROFESSORSHIP OF CHEMICAL TECHNOLOGY—The Vice-Chancellor, University of Madras, Triplicane P.O., Madras, India (March 31, by cable; at the same time advise the Office of the High Commissioner for India, General Department, India House, Aldwych, London, W.C.2).

TECHNICAL DEVELOPMENT OFFICER—The Executive Officer, Bucks. War Agricultural Executive Committee, County Offices, Aylesbury, Bucks. (March 31).

DIETITIAN-IN-CHIEF—The Secretary, University College Hospital, Gower Street, London, W.C.1 (March 31).

DIRECTOR OF THE ELECTRICAL DEPARTMENT (location, Bahamas)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.773A) (March 31).

BOROUGH ELECTRICAL ENGINEER to the Great Yarmouth Corporation—The Engineer and General Manager, Electric House, Regent Road, Great Yarmouth (March 31).

ASSISTANT CHEMIST for the Shellac Research Bureau at Edinburgh—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.1994A) (March 31).

LECTURER IN THE MECHANICAL AND CIVIL ENGINEERING DEPARTMENT—The Registrar, Technical College, Sunderland (April 3).

SENIOR LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN BUILDING SUBJECTS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (April 3).

GRADUATE TEACHER OF GENERAL SUBJECTS, particularly MATHEMATICS—The Principal, Leicester College of Technology and Commerce, Leicester (April 5).

DIRECTOR OF THE ART GALLERY AND MUSEUMS—The Town Clerk, Council House, Birmingham 1 (endorsed 'Art Gallery Director—Room 1') (April 12).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee, Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

DRUMMOND PROFESSORSHIP OF POLITICAL ECONOMY—The Registrar, University Registry, Oxford (May 13).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

LECTURER IN THE ENGINEERING DEPARTMENT (chief subject ENGINEERING DRAWING and DESIGN up to Higher National Certificate standard) of the Bournemouth Municipal College—The Director of Education, Town Hall, Bournemouth.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

London School of Hygiene and Tropical Medicine, incorporating the Ross Institute. Report on the Work of the School for the Year 1942–43. Pp. 42. (London: London School of Hygiene and Tropical Medicine.) [162

Imperial Forestry Institute: University of Oxford. Nineteenth Annual Report, 1942–43. Pp. 12. (Oxford: Imperial Forestry Institute.) [172

The International Secretariat of the Future. Lessons from Experience by a Group of Former Officials of the League of Nations. (Post-War Problems.) Pp. 64. (London: Royal Institute of International Affairs.) 2*s*. 6*d*. net. [212

Ministry of Health and Department of Health for Scotland. A National Health Service. (Cmd. 6502.) Pp. 86. 1*s*. net. A National Health Service: the White Paper Proposals in Brief. Pp. 32. 3*d*. net. (London: H.M. Stationery Office.) [212

Catalogues

The Microtimer. Pp. 2. (London: R. K. Dundas, Ltd.)

Catalogue of Books on Various Subjects. (Catalogue No. 670.) Pp. 74. (London: Francis Edwards, Ltd.)

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EDUCATION OF THE CHEMIST

THOUGH the outlines of the post-war world are still nebulous, it will certainly be an impoverished world, and a world in which Britain will confront immense opportunities but with sadly straitened resources. Times cannot fail to be hard. Even were we to resign ourselves ignobly to the selfish minimum, life would be no pleasant routine of short hours, bread, and circuses. It will be very much more rigorous if, following the deeper aspirations of the national conscience, we accept—and act upon—the belief that Britain has a mission of leadership.

So much is common ground. If we then assume, as we are justified in assuming, that Britain will shoulder whatever tasks are indicated by the finger of duty, we must ask ourselves how best to prepare for what lies ahead. The air resounds with words, but the ideas to be associated with them are often tenuous and elusive. 'Reconstruction' and 'rehabilitation' arouse different images and different reactions in different minds ; even 'planning', to some minds, carries a tang of bureaucratic meddlesomeness which excites a 'never-shall-be-slaves' antagonism. Where we can scarcely be at variance with one another is in postulating that the first necessity at the present time is forethought.

No government, especially amid the exigencies of mortal war, would be capable of taking all the forethought demanded by so critical and so unfathomable a future. It follows that the problem must be partly delegated to, or spontaneously attacked by, individual national bodies capable of dealing usefully with particular aspects of it. A start has already been made in this direction in more than one quarter, and it is very satisfactory to note that, at the initiative of the Royal Institute of Chemistry, serious consideration has been given to the question of the education desirable for young chemists*. It is very satisfactory for the plain reasons that ingenious and economic exploitation of natural wealth will be an indispensable condition of our future existence, and that in this exploitation chemists will be key men. The recruitment of an adequate number of chemists and also their quality and their training are therefore of vital importance. Quality is not wholly controllable. It depends on a complex interplay of biological, sociological, and other factors ; but there is no reason to suppose that coming generations will be any less fertile in chemical ability than those of the past. Training, on the other hand, may be shaped at will, and thus of any proposed scheme of chemical education it is legitimate to ask two questions, namely, whether it is likely to produce a sufficient supply of skilled chemists of various kinds, and whether it affords encouragement for the development of administrative and similar abilities—that is, whether it looks forward to a state of affairs in which the chemist and his fellow men of science will exert in public, industrial and social matters an influence

* The Education and Training of Chemists : Report of the Chemistry Education Advisory Board. Pp. 16. (London: Royal Institute of Chemistry.)

proportionate to their intellectual capacities and to the natural forces they control.

We thus turn with interest to the report of the Chemistry Education Advisory Board set up in 1943 under the auspices of the Association of University Teachers, the Chemical Society, the Royal Institute of Chemistry, the Science Masters' Association, and the Society of Chemical Industry, two nominees of the Association of British Chemical Manufacturers having been later co-opted as members of the Board in order to represent employers. One may note with some surprise that, although two of its fellows were on the Board, the Royal Society was not officially represented; neither was the British Association.

The report deals with its thesis under the following main heads: chemistry in schools, chemistry in the universities, the education and training of industrial chemists and chemical technicians above the minimum school-leaving age, part-time education up to the age of eighteen, the training of chemists in the professional grade, and the supply and training of teachers. It will be observed that while the terms of reference are reasonably wide, they do not embrace, except incidentally, the second of the two questions posed above. Though this may cause disappointment, the omission is understandable, but we hope that the Board—which is probably to remain in being—will repair it as soon as opportunity offers. No feeling of diffidence should hinder full expression of informed opinion upon a matter of such consequence. It is, of course, a sound principle to consolidate each position before assaulting the next, but caution may be carried too far. The present report could well have been the vehicle of a bolder pronouncement upon the part that should be played in the community by the chemist in particular and the scientific man in general.

This criticism must not be taken to imply dissatisfaction with what the report does in fact provide. The contrary is true. The composition of the Board shows it to be widely representative, and the report contains observations and recommendations worthy of the closest possible attention. We may consider some of them here. Since we have referred to the merely incidental treatment in the report of the broader aspect of chemical education, we take first a point in which this aspect is touched upon, so to speak, in reverse. The Board expresses the opinion —in which we fully concur—that it is a matter of great importance "that those, more especially, who will afterwards become leaders in industry and commerce, civil servants and administrators, should become more fully imbued with the spirit of science and should gain both a fuller appreciation of the scientific method and a greater understanding of the power of scientific knowledge and research". The sentiment is unexceptionable; but what we miss is any sufficient suggestion as to how the education of chemists (whom we may regard as typical of scientific workers as a whole) should be modified so that they too might, if they chose, become leaders in industry and commerce, Civil servants and administrators. It is, indeed, a remarkable fact, and we think a deplorable fact, that while many choices of career are open to the man who reads one of the humanities at the university, there is a very much more restricted choice for the science graduate. How far this is due to the structure of society and how far to a remediable defect in university courses may be difficult to determine; but, in spite of such notable exceptions as Sir Stafford Cripps, the rule remains. It is a rule which men of science should exert themselves to eliminate.

Before proceeding to discuss other points of the report, we may make passing reference to the astonishing, and we believe retrograde, opinion of the Board that "for those [post-School Certificate school] pupils who are studying Natural Science as a part of general culture rather than as a part of technical training, practical work in the laboratory need not be required". This may be a majority opinion; there are schoolmasters on the Board, and we find it difficult to conceive that they, who must have witnessed at first hand, and on countless occasions, the all-vivifying effect of laboratory work upon their classes, should have concurred in it. Unless, indeed, we are to look for a clue in a subsequent sentence: "it has to be borne in mind that the time consumed in practical work, if insisted on, may lead, in the case of the pupils under consideration, to the abandonment of instruction in Natural Science altogether". This would provide another example of the Board's apparent diffidence, and one would be tempted to invoke the shade of Danton: "De l'audace, et encore de l'audace, et toujours de l'audace !"

Turning next to the question of university entrance scholarships, we are glad to find that the Board wholeheartedly supports the views expressed by the Norwood Committee regarding the urgent need for a remodelling of these examinations. If the whole basis of the education of the science pupil "is to be broadened, the requirements of the scholarship examination must similarly be broadened", and the examination must give proper credit not only for the special scientific ability but also for the general education of the candidate. In the words of the report, "merely to include subjects of general culture in the school curriculum without giving due weight to them in the scholarship examination, would not prove effective".

In themselves, however, the university scholarship examinations are not solely responsible for the excessive specialization in the post-School Certificate years at school. Part of the blame must be borne by the Higher School Certificate, and the Board recommends that this examination, too, should be suitably modified by the inclusion of non-scientific subjects for the science specialist. This would necessarily mean a somewhat lower standard of attainment in individual science subjects, and therefore ties up neatly with the further opinion of the Board that exemption from attendance at a first-year course at a university is undesirable. Here again we are in full agreement with the Board.

As to the university courses for the intending chemist, the Board recommends that they should be so adjusted as to make possible participation in the general intellectual, social, and recreational life of the university or college. "The student of chemistry should

have time not only to read and think about his specialist studies, but also to mix with men studying other subjects than his own and thereby broaden his general intellectual interests and enlarge his outlook". It is an arresting reflection upon present conditions that such a recommendation should be necessary.

The Board further believes that it is of importance to emphasize that industry requires, and can make use of, for administration, research, laboratory and process operations, etc., not one type alone but many types of chemists, chemical assistants, and chemical technicians, whose education and training may vary greatly and proceed along diverse lines. Opportunity and suitable educational facilities should be provided to enable a worker beginning his career in any one of the lower grades to pass to a higher grade and to attain the highest qualification and professional position to which he may aspire, and for which he shows himself fitted. For these reasons, the Board welcomes the Government's intention to establish compulsory part-time education up to the age of eighteen, and suggests that the special requirements of young chemists should, at the minimum school-leaving age, be reviewed and care taken in assessing their abilities and in giving guidance with regard to their further education and training. This might be done in the larger centres by setting up advisory committees consisting of representatives of the schools, of universities, of technical colleges, of chemists in industry, and of the Royal Institute of Chemistry. Power might also be given to such advisory committees to recommend suitable part-time students for the award of scholarships or bursaries to enable them to continue their education at a university or technical college.

These are sound and practicable suggestions, which clearly ought to be put into operation at the earliest opportunity. The same may be said about the Board's views on the technical education of chemical technicians and chemical works operatives, that is, young employees and skilled or semi-skilled craftsmen who require a knowledge of chemistry and chemical technique but in whom no high standard of academic attainment is needed or expected. Even with such men, however, the Board feels quite properly that the standard of education—general, scientific, and technical—should be raised as much as possible, and that this is one of the main reasons, so far as chemical industry is concerned, why the minimum school-leaving age should be raised and compulsory part-time education introduced.

Two concluding topics treated by the report are the training of chemists in the professional grade, and the supply and training of teachers. On the first, the Board feels that the first three years of a university or higher technical college course should be comparatively free of technology, and that only in the fourth year should technological subjects take first place. On the other hand, during his undergraduate years, the student of chemistry should be encouraged to visit as many industrial works as possible, in order to acquire some insight into the large-scale applications of chemistry and the conversion of laboratory operations into industrial processes. Before the War, vacation courses for undergraduate chemists were arranged by certain manufacturing firms, and the Board hopes that similar facilities, on an increased scale, may be offered by chemical manufacturers after hostilities cease. The Board is also of opinion that it is important to develop much more fully than hitherto the establishment of graduate schools of technological study on lines such as those followed at the Massachusetts Institute of Technology.

Finally, on the supply and training of teachers, the gist of the report is that—particularly in technical colleges—scales of payment are not at present adequate, and that the only way to ensure sufficient teachers of the desired character and calibre is to make the conditions of service sufficiently attractive. That it should be easier to make this recommendation than to implement it is unfortunate, for the provision of the requisite number of competent teachers is patently one of the linchpins of the whole educational vehicle. But experience of the last four or five years has shown that money can always be found when hard necessity calls; and it is for the Chemistry Education Advisory Board and other chemical and scientific bodies to convince the country of the urgent necessity of mobilizing and arming the total strength of Britain's chemical forces.

INDUSTRIAL POLICY AND EMPLOYMENT IN GREAT BRITAIN

THERE is much that is of real interest to scientific workers in the report, "Work: the Future of British Industry", which has recently been prepared by the Sub-Committee on Industry and issued by the Conservative Central Committee on Post-War Problems. In origin and trend, the report is avowedly a party document, but it attempts in the first place—and succeeds in so doing—to show the measure of agreement that already exists on industry and economic policy between the chief political parties in Great Britain. Largely it is a statement of principles, and it clearly owes much to such previous documents as the Unilever paper, "The Problem of Unemployment", the Nuffield College papers on "Employment Policy and Organization of Industry after the War" and "Industry and Education", and sundry others on reconstruction and industrial policy.

The extent to which there is common ground as to the approach to post-war problems and our attitude to them, rather than on the measures by which they are to be solved—for, as will be noted later, the report gives little hint as to a policy—may be illustrated by a few examples. Once again we find emphasized the interdependence of industry and agriculture, the importance of the growth of industrial management as a salaried profession, and of the new educational reforms in widening the sphere of recruitment for such positions as well as in raising the standard of skill. The necessity of developments in technical education is specially stressed; and in welcoming closer collaboration between industry and commerce and the education service, there is a pointed reference to the need to include the universities.

What is said here on the purpose of industry, not merely as producer of the goods required to raise continuously the standard of living for all, to earn the means of paying for the necessaries we must import from abroad, and as a means of livelihood, but also on its being for millions a large part of life itself, implies an attitude which is the real starting point for all human developments in industry and the creation of the right atmosphere for true efficiency. Recognition that the nature of the work, the mental atmosphere, the material environment, the contacts with fellows, with seniors and with subordinates must necessarily enrich or impoverish the lives and outlook of the workers, and through them the life and outlook of the nation as a whole, is the true starting point for developing co-operation whether through joint production committees or in other ways. Once again, we find a welcome for the 'staff college' idea; and the observations on training for management, health services and welfare, hours of work, status and responsibility should be endorsed by all shades of opinion. Moreover, while emphasizing the place of trade unionism and its value as a training for democracy, there is a timely reminder that trade unions were not established to be the preserve of any one political party.

Again, the report faces the future with emphasis on opportunities rather than on difficulties. The prime need is readiness to pioneer and face risks. It is essential to encourage the spirit of initiative, of adventure, of hope, not to go slow and play for safety. In keeping with this, we find that the report not only recognizes the importance of overthrowing all sectional obstacles to human efficiency and restrictive practices, but also, in keeping with other recent reports, urges the need in many branches of industry for a new awakening to the importance of organized research and to the scale on which British industry must further and utilize the advances of science. A major factor in determining the future prosperity of Great Britain will be the full use of our inventiveness and technical skill. More trained scientific workers, a strong development of scientific research in universities and far greater encouragement and scope for scientific men in industry—all these are urged in the report. Once again it is argued that the manner in which experimental and development work is treated for taxation purposes is restrictive and tends to impede application of results of research to the factory, but the need for change in taxation policy comes second to that for an awakening among those who determine financial policy in industry to the part which science has to play in the future of British industry.

On the question of the relations between government and industry the report recognizes the need for building up a practical system of government, but on the broad question of the structure of industry the report is scarcely as open-minded as, for example, Mr. S. Courtauld in some of his recent utterances, and is inclined to prejudge the issue. In accordance with suggestions in Parliamentary debates and in the Nuffield College paper, it regards new measures for training the staffs of Government departments concerned with industry, and especially export problems, as essential, so that they can instinctively appreciate those problems from inside. It calls for dynamic co-operation between industry and Government departments, and looks for a Ministry of Industry and Commerce inspired by a more positive and constructive conception of its duty to help British industry to grow healthily, make good any weaknesses, sell its goods and provide employment. Among its suggestions are a panel of advisers to a Ministry of Industry, chosen from among the best men available in the industrial field, as well as a highly qualified research staff, attached to the Ministry if not to the Cabinet offices, so that, when Government policy is being shaped, expert advice on any relevant aspect can be taken into account.

These suggestions are independent of the general character of industrial enterprise; but there are other comments, for example, on the future of controls and on the location of industry, which represent a large measure of agreement among progressive opinion. The reasons for continuing controls after the War are well formulated, and taken with Sir Stafford Cripps's recent statement and Mr. Bevin's speech to the cotton trade on January 7, should do something to take this question out of the field of faction and place it in its true perspective. In regard to the location of industry, many of the proposals of the Barlow Report are clearly supported. The imperative necessity of ensuring that the national interest is paramount in all decisions in this field, and that it is not obstructed or thwarted by sectional interests, is the crux of the case for the National Industrial Board recommended in that report; although the necessity for central machinery and powers is admitted in veiled terms which do not distinguish between the majority and the minority proposals.

After discussing monopolies, trade associations, etc., the report makes the essential point that is often overlooked in such discussions: technical progress, skilled administration, and good workmanship—these, and not a new political system, can raise the standard of living. A new political system might, of course, contribute to raise the standard in any one of these three directions. The real question is what forms of organization are most conducive to efficient and successful management in any and in every field of industry.

A welcome feature of the report is the support accorded to international co-operation. In the Committee's view, the greatest single cause of the severe unemployment which afflicted practically every industrial country at some time or other between the two wars was the failure of the nations to diagnose unemployment rightly as a world problem, and to collaborate confidently with each other in policies correctly designed to remedy its deep-seated causes. It should be a prime aim of British policy to ease the way to economic collaboration among all the United Nations in accordance with the fifth point of the Atlantic Charter.

The necessity for new developments of international economic machinery is recognized, as well as the expansion and strengthening of existing institu-

tions such as the International Labour Office. Further, a new international currency agency is suggested, whatever differences of view exist about the manner and rules of its operation. General stability of exchange-rates is a prime necessity in laying firm foundations for the recovery and continued growth of world trade, and the provision of massive credits for rehabilitation is given strong support.

The report expresses the hope that the United Nations will also put boldly in hand long-term constructive plans for world prosperity. Stable and reasonable prices for primary producers are necessary, not only for the sake of farmers, but also as an insurance against the shocks which widely fluctuating prices of agricultural products cause to trade and unemployment. As the Hot Springs Conference recommended, a body of broad principles should be reached, through international discussion, regarding the planning and structure of international commodity agreements. The emphasis is laid on regulation, not restriction.

Support is also forthcoming for proposals to raise the economic standards of backward peoples. The awareness of the possibilities in raising standards of living and welfare, undertaken on sound economic and scientific lines, is a welcome feature of the report, which recognizes that the increase in world purchasing power thus created would flow back to become a further safeguard against under-employment in the industrial countries. The report appears to favour entrusting these tasks to international reconstruction and development agencies as visualized by Political and Economic Planning. Here again we find the need for accurate data emphasized, and it is urged that an essential step in stabilizing employment is an international statistical service.

An important section of the report is devoted to export policy in relation to employment. Here, pleading for further government support, the Committee advocates not subsidies but the removal of any handicaps on export business which it is in the power of the government to remove, and the fullest co-operation between industry and government in the examination of acute export problems. The dependence of social security on a policy of employment is recognized, as is the value of public works, though here the report is much more guarded than the Unilever statement. Public works should be treated as a buffer against depression, not as a cure for it; but priority should be given to projects making for efficiency, whether of industry, agriculture or transport, or the quality of our people—a Severn bridge, a road bridge over the Forth, port facilities, and school buildings are indicated.

The report, taken as a whole, is characteristic of progressive thought, independent of party, and the measure of agreement thus indicated as to the direction, if not necessarily of the tempo and methods, of advance should help to eliminate faction and facilitate the initiation of some of the large measures immediately required. Moreover, such agreement should at least facilitate the scientific approach to the problems of reconstruction, and help to secure that, whatever action is taken or policies formulated, they are at least in keeping with the demands of the facts which scientific inquiry has brought to light. The Labour Party's adoption of a memorandum on food prepared by Sir John Orr as its own official policy may well be regarded not merely as a sign of a non-partisan approach to this vitally important problem, but also as an indication of the possibility that party programmes and policies may at least start from common ground in the results of impartial scientific investigation of the technical aspects of the problems concerned.

While in this way the scientific method may help to eliminate the demagogue, it must be remembered that the scientific and technical issues, important as they may be, are, as a rule, only a part of the problem. As to the means of dealing with the social and political aspects, there may well be, and usually are, alternative solutions. Accordingly it is not sufficient, as the Conservative Sub-Committee on Industry has done in this report, to make clear the measure of agreement on objectives. It is necessary for policy also to be formulated, and for the differences between the practical measures proposed by different political parties to be made equally clear. This present report fails to do this, but unless and until it is done (whether for or by the electorate), a democratic system cannot function effectively.

THE BORDERLAND BETWEEN PHYSICS AND MUSIC

The Physics of Music

By Dr. Alexander Wood. Pp. xii+256+14 plates. (London: Methuen and Co., Ltd., 1944.) 21s. net.

DR. WOOD is known to many generations of Cambridge physicists as an excellent teacher of acoustics, and to an even wider circle as a writer of text-books on the same subject. In his latest book he is equally successful in "the very interesting borderland between physics and music" in which so much new knowledge has been gained in recent years. He has written a most useful and valuable book, from which both physicists and musicians can learn a great deal.

The first five chapters expound the general theory of sound, with no very marked emphasis on music, and lead up to a good chapter on the ear and the mechanism of hearing. The next three chapters deal fairly exhaustively with the production of sound by musical instruments—strings, organ pipes, the human voice and orchestral instruments, both wind and percussion. Then come four varied chapters on dissonance and consonance, on scales and temperament, on the mechanical and electrical reproduction of sound, and on the acoustics of halls and concert rooms. This last is a most valuable chapter—or would be if everyone would read it who ought to. For, although the situation has greatly improved of late, many of our auditoria form standing monuments to a want of co-operation between scientific men, musicians and architects. Here Dr. Wood tells us what can be done and what ought to be done. "Probably," he says, "there is no direction in which co-operation between the musician and the scientist is likely to be more fruitful than that of designing auditoria for music," and the same might have been said of rooms for speaking.

The general reader will find much to interest him as he browses through the pages. He may, for example, be surprised to learn how very sensitive a physical instrument the ear is. A softly played violin gives out only 0·0000038 watts of energy, and yet will fill a good-sized room with audible sound. At a pitch of about 3,500 cycles, the ear can hear waves of sound with an amplitude of motion of less than a hundredth part of the radius of the atom. There is, of course, an obverse to this picture, and we read that all the shouting and cheering at a cup-tie match generates just about enough energy to warm a cup of tea.

The flexibility of the ear is equally striking. A full orchestra emits about 20 million times as much energy as the solo violin just mentioned, yet the ear can register both sounds in comfort and with judgment and discrimination. In technical language, it can deal with sounds of from 0 to 130 phons, where each phon represents an energy-increase of about 26 per cent. Dr. Wood brings home to us the vastness of this range by remarking that one twin crying may give a loudness of 60 phons, while the addition of his brother twin will only raise this to 63 phons. Yet the ear works efficiently up to a loudness of 130 phons—10 million babies crying in unison. After this it is not surprising that we come to the "threshold of pain".

In so far as it is concerned with music, the book necessarily treats sound in a somewhat subjective way. Sometimes we may perhaps wonder if this tendency does not go too far, both in the book and outside it. For example, we read on p. 44 that "pitch is not simply dependent on frequency, but depends also on loudness". By way of confirmation, we are told of experiments by Stevens and Snow in which pitch was found to vary with loudness to a maximum extent of 2½ full tones—a fourth. "The pitch of high tones rises with increased loudness, while the pitch of low tones falls with increased loudness." All this seems to make nonsense until we discover that Dr. Wood defines pitch as a "subjective quality of a sound"; it is "the characteristic of a sound in virtue of which we describe it as high or low". When the *A* of a violin is tuned to the *A* of a piano, a musician will say that the two tones are of the same pitch but of different timbre, meaning that the fundamental and its various harmonics enter into the two sounds in different proportions. But a non-musical listener may describe the violin note as being of higher pitch, because he hears more of the higher harmonics than in the piano note (actually Seashore finds that when the open G is sounded on the violin, the amazingly small fraction of 0·1 per cent of the energy resides in the fundamental, as compared with perhaps 20 per cent for the piano). Now Dr. Wood apparently bases his definition of pitch on this kind of non-musical judgment. The results might well have been disastrous, but happily are not. For within five pages the author has forgotten his own definition of pitch, and is telling us of the new international standard of pitch, "440 cycles per second for the note *A* in the treble clef", with no mention of the loudness with which the note *A* is to be sounded. The matter is not wholly unimportant, in view of recent attempts to use the experiments just mentioned as proof that musical theory cannot be based on scientific principles. If pitch varied with loudness in the way claimed, every chord of music, as it died away into silence, would resolve itself into a succession of ghastly discords, in direct contradiction to the experience of every musician who has ever listened to music.

On this particular question, true music and true science are probably in full agreement; but there are a number of other questions on which they are inclined to give different verdicts. In particular, there is the question of whether distinctive emotional characteristics are associated with the various keys in which music can be written: Is the emotional quality of a piece changed when it is transposed from *C* to *D*—or even from *C*♯ to *D*♭? Many musicians say yes; they can recognize an emotional change, even when the music is performed in equal temperament (in which case the various keys differ in nothing physical except pitch, and *C*♯ and *D*♭ do not even differ in this). Most scientific men think this is a pure illusion, or at best a carry-over of associations from a time when equal temperament was unknown. Dr. Wood discusses all such problems very judicially and fairly. If any criticism is to be made, it is that he stands too modestly aloof; his summing-up gives but little guidance to the jury.

The book gives an adequate account of the large amount of acoustical research carried out in recent years, especially in the United States; in general it is well-written and readable, interesting, authoritative and accurate. Thus it can be warmly recommended, and especially to those musicians who wish to know more of the science in which their art has its roots.

J. H. JEANS.

THE NEW ORDER IN INORGANIC CHEMISTRY

Inorganic Chemistry

By Fritz Ephraim. English edition by Dr. P. C. L. Thorne and Dr. E. R. Roberts. Fourth edition, revised. Pp. xii+922. (London and Edinburgh: Gurney and Jackson, Ltd., 1943.) 28s. net.

THE standard text-books in advanced inorganic chemistry at the service of past generations presented the reader with a gigantic jumble of disconnected data. One great unifying principle—the periodic classification of the elements—was indeed recognized; but it was admittedly riddled with exceptions. Small wonder that the majority of students, on reaching the research stage, preferred the severely systematic field of organic chemistry; order is always more attractive than chaos.

To-day the state of affairs is different. Our detailed knowledge of atomic structure, founded on the work of Rutherford, Moseley and Bohr, and our disentanglement of the vexed topic of valency into distinct types, dependent upon the extent to which electrons are transferred or shared between combining atoms, render it possible to develop inorganic chemistry as a coherent whole. The volume under review affords an outstanding, though not a unique, example of the success that can be achieved in this direction. It is true that it is not suitable for the beginner—a very solid basis of elementary facts must still be accumulated before any general theories can be built upon them—but it will undoubtedly appeal to the more advanced student, provided he is not deterred by the first few chapters. These are, perhaps necessarily, very heavy going, but the tension eases as the book proceeds, and the last chapters in particular are packed with material that cannot fail to fascinate and instruct even the expert.

The success of the volume, first issued in English in 1926, is proved by the present attainment of its fourth edition. Each revision has introduced marked improvements. The original text, although good in general, contained a number of almost unbelievable 'howlers'; these have now been carefully eliminated and only a few minor defects remain. For example, the simultaneous presentation of the old idea that a positive charge on an ion is something tangible that can be handed around, and of the newer conception that a positive ion is produced by the loss of an electron (pp. 151, 155, 163), is bound to cause confusion. The fact that the reaction $2Cl_2 + 2H_2O \rightleftharpoons 4HCl + O_2$ is effectively reversible, while the reaction $Cl + HBr = HCl + Br$ (presumably Cl_2 and Br_2 are intended here) is not, cannot be explainable by the statement (p. 218) that the electro-affinities of the elements competing for the hydrogen are more similar in the former case, since exactly the opposite is true (see the table on p. 15[illegible]). A similar inconsistency is the inclusion of nitrous acid in the list of substances illustrating Luther's rule (p. 376), according to which nitrous acid must be a more powerful oxidizing agent than nitric acid, followed later (p. 69[illegible]) by the remark "nitrous acid is a somewhat weaker oxidant than nitric acid". The "change in volume" factor cited as the primary influence in determining the heats of solution of gases, liquids and solids (p. 401) is generally insignificant compared with the "change in state" factor, which is not even mentioned.

Direct references to original investigations are numerous, and useful instructions to the student on how to look up the literature before commencing a research are furnished in a special appendix. Unfortunately, the editors have not always followed their own precepts, and several inaccuracies in the text-matter are directly attributable to the antiquity of the accompanying references. Instances are the polyammines of the hydrogen halides (p. 6[illegible]6) and the acid sulphates of the alkali metals (pp. 581–2).

These, however, are merely subsidiary blemishes in a volume which, on the whole, reaches a very high standard and merits the most cordial recommendation.

JAMES KENDALL.

THE END OF THE NATIONAL STATE

The Crisis of the National State

By Dr. W. Friedmann. Pp. ix+198. (London: Macmillan and Co., Ltd., 1943.) 12*s*. 6*d*. net.

DR. FRIEDMANN has developed in this book a striking theme that demands attention. This is that the National State, by a species of historical dialectic, has reached the end of its development and now passes over into neo-imperialist forms. There is no book on political theory that I have seen during the past year to compare with it in brilliancy or one that I would more readily put into the hands of statesmen and politicians.

It is relevant to Lord Halifax's recent proposals that Dr. Friedmann regards the British Empire as not one of the world's *Grossraum-ordnungen*. "It lacks the essential features of *Grossraum*: unity of space and communications, and consequently economic self-sufficiency in the face of modern war. The British Empire is, indeed, the expression of a past phase of Empire". Like the Habsburgs, the British monarchy and Government have concerned themselves with building up higgledy-piggledy a heterogeneous collection of estates, without cultural or any other unity, all over the map. To put Dr. Friedmann's contention in a more brusque form, the British Commonwealth, in abstraction from the West, including the United States, has no future. A brief inspection of geography and population factors should show us this truth, but, for obvious reasons of prestige, politicians will not attend to these considerations until the time comes when it is too late to unify the West, too early to unify the world, and world direction must necessarily pass into more vigorous Eastern hands. Having won the War we shall have effectively ended in the humiliating position of France in 1918, which explains her obeisance to the inevitable and her fall in 1940.

Dr. Friedmann's major theme, however, is based on a study of German nationalism. This, reaching a paroxysmic intensity in Nazi racial theory, then undergoes transformation (comparable to Roman imperial transformation from the close corporation of *cives Romani*, claiming patrician descent from Romulus) into a new imperial form, where Hitler is frank to admit that there is little opportunity for German nationalism as distinct from membership of an international ruling order of administrators and secret police. The logic of nationalism, as group appetite for power, is that it moves from being power for my nation into being my nation's power supranational over other nations, that is, national imperialism, and then into being power for all bureaucrats, of any nationality, who can functionally contribute to maintain the supra-national imperial power.

The weakness of most contemporary theorists is either that they under-estimate the factor of power, and believe in some kind of liberal pre-established harmony where every country keeps its own army solely to distribute U.N.R.A.'s food supply, or that they seriously believe that any accumulation of power can solve the essentially mental problems of human psychology, ambition and discontent, to-day idealized as 'dynamism'. We suffer from an absence of police which we have never had since Rome fell; and from a breakdown of humanistic education in civilized corporate living which is quite recent—and is expressed by the nihilism of Sorel. Dr. Friedmann fully appreciates the first point, but (unlike Dr. Mannheim) does not dwell on the second.

Dr. Friedmann concludes by favouring regional federal associations or multi-national associations within the framework of a world institution of the United Nations. As touching the orthodox theories of technico-economic organization—the form of 'functionalism' criticized by the present writer elsewhere (*Contemporary Review*, Sept. 1943)—Dr. Friedmann points out that, far from economic necessity compelling internationalism, to-day new developments permit, to some countries (for example, the United States and the U.S.S.R.), regional autarky as never before. Further, "the various political philosophies which dominate international politics in our time are at one in subordinating economic and technical developments to political will. It depends more and more on the latter whether economic conditions will be developed on a national or international scale". The Roosevelt-Eden school of economic-technical collaboration, vestigial from the epoch of economic man, shirks the major issue of a common political will, because it wishes to do so, and is already out of date in the politics of power.

GEORGE CATLIN.

BRAIN RHYTHMS*

By PROF. E. D. ADRIAN, O.M., F.R.S.
University of Cambridge

IN 1929 Prof. Hans Berger, of the Psychiatric Institute at Jena, published the results of some work on which he had been engaged for many years. He had set out to record the electric currents developed in the human brain, and had shown that if metal electrodes were fixed to the scalp, it was possible to detect a regular oscillation of electrical potential which was not due to muscles or skin glands or any other source outside the skull, and could only have come from the nerve cells of the cerebral cortex. The oscillation had a frequency of 9–10 a second. It only appeared when the subject was at rest with attention relaxed and eyes closed; but it obviously represented some kind of continuous activity in the brain covering a fairly large area. What he discovered was then quite unexpected. It has made us revise many of our ideas about the brain and has brought us a little nearer to understanding what goes on in it.

The oscillation, Berger's α rhythm, represents a very small change of potential, about 50 microvolts, and a very small ebb and flow of current in the cerebral cortex. There is nothing unexpected in the fact that brain cells develop small currents when they are active, for all active cells do so. The unexpected thing is the regularity of the rhythm. It is true that if it were not so regular, it might never have been detected, but the regularity means that large numbers of brain cells must be working in unison at the same rate. We should have expected something much more complex and variable—activity varying from moment to moment and from place to place—and not the uniform pulsation shown in a typical record of the electroencephalogram.

We should have expected this because the brain is a great sheet of nerve cells and interlacing nerve fibres, and its working must depend on the spatial distribution of activity in it. This is determined by the particular pathways which must be taken by the incoming and outgoing messages, for the messages are all in the same form wherever they come from, and it is because they arrive in different regions that we interpret one as sight and another as sound. We know, for example, that if one looks at a bright cross, the initial event in the brain will be the activation of a more or less cross-shaped area at the back of the occipital lobe, and that if one hears a sound a pattern will be reproduced in the temporal lobe corresponding to the areas of vibration in the cochlea. All the external events of which we are aware are recorded as spatial and temporal patterns of excitation in the sense organs. These patterns are reproduced in the brain with a good deal of editing, omission of details and heightening of contrasts, and it is from them that we reconstruct our external world.

Now the α rhythm of the electroencephalogram comes from large areas in the occipital region and to some extent from the frontal area as well. At first sight this seems to leave little room for all these diverse patterns of electrical activity. But actually the regions where the potential change is at a maximum are not those where the messages from the sense organs are received in the brain, but are the neighbouring 'silent' or 'association' areas. Also, to make the rhythm appear, the eyes must be closed and the attention relaxed, so that the brain is relatively inactive, at least so far as vision is concerned. Thus the regular wave sequence is derived from certain parts of the cerebral cortex when these have little to do. The cells there are not concerned with the incoming signals and so will be free to beat in unison, and if fairly large areas are so beating our records from the head will show the α waves and will not show the small local irregularities which are probably going on all the time so long as we are conscious.

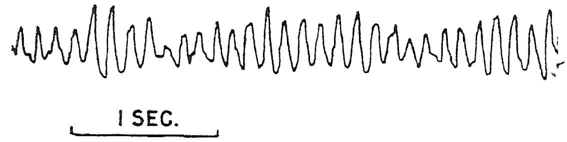


FIG. 1. NORMAL ELECTROENCEPHALOGRAM SHOWING THE α RHYTHM. THE MAXIMUM POTENTIAL CHANGE IS 45 MICROVOLTS.

The cells of the cortex might beat like this when they are left alone because this is how they are made; because like heart muscle or ciliated cells they cannot remain alive and inactive; or the beat might be imposed on them by rhythmically active cells in some other part of the brain which can act as pacemaker to the association areas. Wherever the pacemaking region may be, the important fact is that the rhythm is much the same from one person to another. For clinical purposes, therefore, an electroencephalographic recording can be used as an index to show whether the brain is working normally or not, and for this reason it has become an important technique of clinical neurology. Apart, however, from the value of these records as a means of diagnosis, there is the problem of their significance in relation to the normal mechanism of the brain and of the mind. Do they tell us anything about the neural accompaniment of perception and thought?

The statement that one can record the electrical activity of the brain through the skull raises the hope that one should be able to detect all sorts of brain events connected with consciousness. The hope begins to fade when it is realized that the main feature of our records is a rhythm from nerve cells which are relatively inactive. But there is something of interest to be learnt from them. It is true that we cannot yet record the detailed activities of different parts, but only the gross changes when a whole area goes into action; yet these do give us some novel information about the physical accompaniments of thought and in particular about the process of attention.

To begin with, it seemed that the α rhythm was much less interesting. It might have been merely a spontaneous beat of the nerve cells in parts of the cortex, particularly those concerned with vision—a beat developing whenever the cells were not stimulated by messages from the eyes. Opening the eyes would break up such a rhythm in the receiving area, because the visual pattern there would mean that different groups of nerve cells would be discharging at different frequencies. Something of this kind can certainly happen in the regions where a message enters the cerebral cortex, for in records from the exposed brain (in anæsthetized animals) the arrival of a message in the receiving area produces small, rapid waves in place of the slower and larger α

* Friday Evening Discourse at the Royal Institution delivered on February 4.

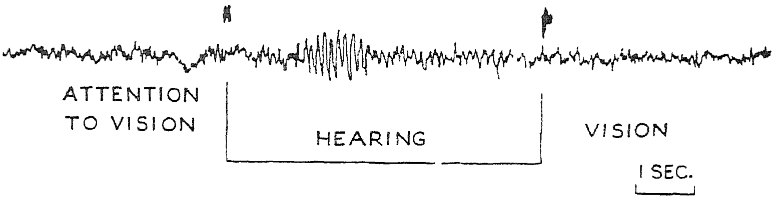


Fig. 2. The α rhythm appears when the attention is transferred from vision to hearing. The visual field has been made unattractive by + 10 *D* spectacles during the middle section of the record the attention is concentrated on the tick of a watch.

rhythm. But the α waves are not confined to the receiving areas of the brain, and it can be shown that in fact the presence or absence of messages from the eyes is not the essential condition for the disappearance or return of the α rhythm.

As far as vision is concerned, what really determines the presence or absence of these waves is not whether visual messages are or are not coming into the brain, but whether we are or are not attending to them—whether we are looking at anything. Man is a visually controlled animal, and if our eyes are open there is usually something in the visual field which catches our attention or some part of it. This is not true for all mammals; the rat and the cat seem to rely more on other senses and can be quite inattentive to sights. But with us the only sure method of shutting out sights from the mind is to close the eyes. Normally, therefore, opening the eyes means that we start looking, or that we become attentive to the visual field. The α waves then disappear, and they return when we close our eyes and cease looking. But shutting the eyes does not cut out all light from the retina, and the α rhythm appears in the brain however much or little light may be falling on the closed lids. Even in a pitch-black room, if we open our eyes and start trying to see something, the rhythm goes, although opening the eyes cannot have altered the illumination of the retina. Sooner or later, when we have given up the attempt to see, the waves will return although the eyes are still open.

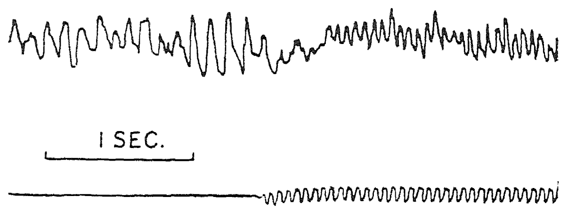
What matters, therefore, is not the excitation of the retina but the turning of attention to the visual field or away from it. This can be shown even more clearly in another way. In daylight and with the eyes open, the attention can rarely be abstracted completely from vision except for short periods; something keeps on 'catching the eye' and coming into the mind, even though we have most of our attention fixed on other things, a sound or a smell, for example. The reason why the visual field cannot be completely ignored is that the picture of it in our brain has patterns and sequences which arouse interest by recalling memories or starting some new train of activity. But if we can make the visual field convey less meaning, it will cease to be so attractive and our attention can leave it more easily. A simple way of securing this is to wear spectacles which will throw everything out of focus. When this is done, although the eyes remain open, the α rhythm will appear much more readily than when the visual field is in its proper focus. With the field blurred, we have only to listen intently to a sound and the α waves will begin, to cease again if we transfer our attention back to vision. Here, too, there has been no change in the illumination of the retina but only the shift of attention. It may be noted that it is not only the intellectual interest of the field which holds our attention. Any movement in it or any sudden change of illumination will do so; and there is a great variation in the ability of different persons to detach the attention from vision, and in the same person at different times.

All this shows that the α rhythm is an activity which appears in the cerebral cortex when the attention is not directed to vision, and disappears when it is. The mental act of looking somehow prevents the α waves from developing in certain parts of the brain, parts which are likely to be concerned in analysing the visual pattern. The α rhythm is therefore a rhythm of inattention, a positive activity which fills those parts of the cortex which are for the moment unemployed. It is not the basic rhythm of unstimulated nerve cells, and there must be some kind of competition between the message from the eyes and from the source of the α rhythm to decide which shall control the cortical areas.

To examine this competition in more detail, we must have some way of recording the sensory activity of the brain as well as the α activity. All the messages which reach the cortex will produce their own electrical accompaniment, and this can be recorded well enough if electrodes can be placed on the surface of the brain. But if we can get no nearer than the scalp, the potential changes generated in any group of nerve cells will usually be obscured by those of other groups near by, and the record will then show us nothing. Fortunately this difficulty can be overcome, in part at least, by making all the cells work in unison. This can be done, as far as vision is concerned, by making the field more or less uniform and lighting it with a flickering light. The nerve cells are then forced to work in unison at the frequency of the flicker, and we can record their electrical activity through the skull up to frequencies of about 30 a second. This gives us a method of tracing the visual messages in the brain, for by means of the flicker rhythm they can be made easy to recognize.

Provided that the flickering area is in the centre of the visual field, it need not subtend more than a few degrees at the eye to give a potential oscillation at the same frequency in the occipital region. The waves are more or less where one would expect them to be, in the right occipital region if the left half of the field flickers, and vice versa. But the flicker waves are not confined to the visual receiving area: they are found also in the neighbouring areas, those from which the α waves come when the eyes are closed. The flicker area is not so large as the α area, but on occasion as much as a quarter of the brain surface seems to pulsate with the flicker rhythm. The retinal messages must then have spread widely and impressed their rhythm on some of the association areas of the cortex.

Now if the eyes are open, the flicker will keep the visual attention engaged and the α rhythm at bay. But if the eyes are closed and the flickering light is thrown on the closed lids, the subject will be conscious of the flicker but the conditions will favour the α rhythm, since closure of the eyes is usually coupled with the withdrawal of attention from vision. In these conditions the two rhythms can be seen to compete for the cortex, and sometimes to co-operate if their frequencies allow of it. The flicker-rate will sometimes appear in patches with the α-rate in between, and if a rapid flicker is turned on suddenly



FLICKER

FIG 3. ELECTROENCEPHALOGRAM FROM THE OCCIPITAL REGION, SHOWING THE CHANGE FROM THE α RHYTHM TO THE FLICKER RHYTHM WHEN THE EYES ARE OPENED AND THE SUBJECT LOOKS AT A SCREEN LIT BY A FLICKERING LIGHT. THE RATE OF FLICKER (17 A SECOND) IS SHOWN BY THE PHOTO-ELECTRIC CELL RECORD BELOW.

the area of the brain giving the flicker rhythm may be large at first and may then shrink rapidly, giving place to the α waves but persisting longer in regions nearer the visual area. If the flicker is made equal to or twice the α-rate, we may find the two summing up to give very large regular waves. Such a combined rhythm usually takes some time to build up as the two sets of waves have to be synchronized, but there is evidently an interaction between them and a tendency to remain synchronized as long as their frequencies are not too far apart. These wave effects vary from one subject to another and there are variations according to mood, time of day, etc.; in general, the sleepier the subject the more the α rhythm will predominate, and the brighter the flicker the more persistent will be the flicker rhythm.

The interaction and interference of these rhythms shows how the cortex, or certain parts of it, may be put at the disposal of our attention. If we decide to look, or if it is decided for us by something 'catching our eye', a change occurs which prevents the α rhythm from occupying the regions surrounding the visual receiving area. If we can turn our whole attention to a watch ticking, the α rhythm comes back. What brings this change about ?

The evidence is still rather scanty. It is likely that the whole of the cerebral cortex is concerned, in that it is the balance of activity in every part which determines where the attention will turn and how long it will be held in one field; but the executive act, the direction of the attention to the particular field, is probably carried out by a relatively small central region in the neighbourhood of the thalamus and near the main incoming pathways. It is from there that the α rhythm seems to be controlled, and it is at least probable that it is the sudden disturbance of this region which causes the loss of consciousness after a blow on the head. This central directing region must act on information received from the cortex, for it will be all the memories and associations stirred up by a stimulus which will determine its interest, and these are presumably not aroused until the message has reached the cortex. But the central region must balance up the conflicting claims of different stimuli and must then decide which should have the main share of the attention, its function resembling that of a central university committee which has to decide which branch of learning should be supported by the next benefaction.

The visual stimuli always get the lion's share. If they are at all interesting, the central region will suppress the α rhythm over the occipital area, so that the visual pattern has a considerable part of the cortex set free for its analysis. When the visual pattern ceases to be interesting and the attention is directed to sounds or other sensory messages, the occipital lobe is not turned over to those but is filled again with the α rhythm. This is shown very clearly in records in which the visual waves are made recognizable by the use of a flickering light, and if the flicker happens to be at twice the α rate a partial diversion of attention will be enough to give the large compound waves at the α frequency.

Apparently the occipital part of the brain is used to analyse sights, and sights only. What parts deal with the patterns aroused by sound and touch we cannot yet say. The areas seem too small to be easily detected, and must certainly be much smaller than the areas which deal with vision. On the other hand, a concentrated mental effort may sometimes abolish the α rhythm although the eyes remain shut. Presumably in this case the whole of the α area may be turned over to non-visual activities.

There are still many gaps in the evidence, but there is much to support the view here put forward, namely, that there is a deep-seated part of the brain which contains the mechanism by which attention is directed one way or the other, and that the α rhythm is under the control of this region, if it is not directly produced by it. If this is so, it is not difficult to understand that abnormalities in the α rhythm are often associated with abnormal kinds of behaviour. The most valuable application of the electroencephalogram in medicine is in the localizing of diseased regions and tumours of the brain by the change in the character of the waves. Another is its use in detecting the sudden explosive discharges of the nerve cells which occur in the brains of epileptics. But quite apart from such obvious disorder of the brain cells, the electroencephalogram may show an α rhythm which is definitely abnormal, irregular, faster or slower than usual or with odd-shaped waves, and in a significant proportion of the subjects who give such records there are abnormalities in the mental or emotional sphere which may be a serious handicap. There are, of course, many factors besides the constitution of the brain which determine whether we react like our fellows or not, but the brain is a not unimportant factor and the electroencephalogram seems to offer a means of assessing some of its deviations from the normal. It remains to be seen whether its use for this purpose will have much practical value: at present the most that can be said is that if we had to appoint someone to a responsible post and had an unlimited field of candidates, it would be safer to exclude the five per cent whose electroencephalogram showed the most unusual features.

That is a very long way from saying that the electroencephalogram can tell us how the subject will think and act. In fact the information which it gives relates to a very limited field. But the limitation arises mainly from the fact that we can only record the gross effects and not the detailed patterns in the brain. With present methods the skull and the scalp are too much in the way, and we need some new physical method to read through them. We need the "patent double million magnifying gas microscopes of hextra power" with which Sam Weller thought he might be able to see through "a flight o' stairs and a deal door". In these days we may look with some confidence to the physicists to produce such an instrument, for it is just the sort of thing they can do; but until it is available we have to confess, with Sam Weller, that "our wision's limited".

A SOCIAL MEDICINE BASED ON SOCIAL STATISTICS

By Prof. P. SARGANT FLORENCE
University of Birmingham

1. Experience in Industrial Fatigue

THIRTY years ago I was appointed investigator to a committee set up by the British Association, meeting at Birmingham, to study "Fatigue from the Economic Standpoint". I took 'economic' as a clue pointing me *toward* the external behaviour of men at work and pointing *away* from studies of the physiology of fatigue internal to a man. The data at my disposal were thus confined to the external conditions likely to influence a man's work and the external tests of a man's efficiency at work. The findings which I first reported[1] about the effect of such conditions as long hours or different types of work upon such tests of efficiency as output and accidents gradually developed into a scheme of study, published in 1924[2], which I have found a useful framework for co-ordinating the results of subsequent inquiries. The scheme is here presented in bare outline.

Special Scheme of Study for Industrial Fatigue

VARIATIONS IN INDUSTRIAL CONDITIONS

Conditions of the workplace	*Conditions of the workers*
Hours and intensity of work	Type of worker employed
Type and method of work	Vocational selection
Physical environment. air, light, noise, etc.	Training and experience of workers
Social and psychological environment:	Wages and living conditions
Supervision and relations within working groups.	
Methods of wage payment, etc.	

CAUSE

VARIATIONS IN THE 'HUMAN FACTOR'

INDICATED BY

Output	*Accidents*	*Lost time*	*Labour*	*Efficiency*
Quantity Quality Economy		(Absenteeism)	Turnover	(Performance tests)

The typical unit investigation consists in keeping a group of workers under observation and determining the form and degree of correlation (or 'co-variation') between measured variations in any one condition, and measured variations in an index test of their efficiency, for example, the law of co-variation between a group's hours of labour and their quantity of output or between temperature of the air and a group's accidents. In any actual situation many variable but uncontrollable circumstances arise, of course, during the period of observation. For this reason these studies were social not only in observing a society such as a factory, but also in depending for the reliability of their conclusions upon a statistical norm for a *whole social group* in which individual deviations cancelled out. They were social not only by choice of subject but also by sheer methodological necessity.

To obtain exact statistical norms both conditions and tests of efficiency had to be numerically measurable, and much of the methodology involved consisted in establishing quantitative indexes. Most of the tests of human efficiency are now standard ratios; even quality and economy of output can be reduced in many cases to percentages of spoilage and wastage. But many of the industrial conditions are harder to measure. Type of occupation, for example, did not at first sight appear capable of statistical assessment. But a preliminary qualitative analysis disclosed quantitatively measurable variables such as length of required training, the frequency of repetitions, regularity of repetition (or rhythm) measured by a low deviation from average in the times of successive repetitions of a job[3]. Social relations and environment are obviously the least easy to reduce to a measure. But the work of Prof. Mayo of Harvard and his collaborators at the Western Electric's Chicago works has shown how much of the overt behaviour of groups of workers can be objectively observed and numerically recorded[4]. Clearly, further research using quantitative methods is urgently needed in the social psychology and anthropology of industrial groups.

Once a statistical co-variation is established, it remains to interpret the precise chain of causation. In my industrial studies I used as a working hypothesis a 'human factor', variations in which were taken (1) to cause variations in the tests of efficiency, (2) to be caused by variations in the industrial conditions[5]. The precise psycho-physiological processes such as fatigue that may be manifested by this human factor, intermediate between conditions and tests, is largely a matter for clinical and laboratory study. This was the point in the scheme where external observations, accurately measured and summarized statistically, gave place to 'internal' experiment and analysis. Such experiment often artificially reproduced the industrial situation in a laboratory. It attempted to test some particular variation in the human factor under conditions deliberately selected and controlled.

2. Application to Social Medicine

The study of industrial fatigue, defined broadly as a study of the variation in human efficiency associated with variations in industrial conditions, is unquestionably a special branch of social medicine, and it is possible that the technique specially developed there may prove useful to social medicine in general. Tentatively I suggest the following enlarged general scheme, which would make the definition of social medicine *the study of the variations in human health and efficiency associated with variations in social conditions*.

General Scheme of Study for Social Medicine

VARIATIONS IN SOCIAL CONDITIONS

(*A*) Occupations	(*B*) Living Conditions	(*C*) Persons Affected
	Home Life	
School or work, if any	(determined largely by income)	
Hours and intensity of occupation	Food	Sex, age, condition (e.g., motherhood)
Physical conditions	Housing	Heredity (physical and mental)
Social and psychological environment	Distance from work	Acquired characters
Type of occupation	Degree of urbanization	Education
Unemployment	Medical attention	Vocational training
	Family relations	Background and experience
	Recreation	
	Community Services	
	(determined largely by central and local government expenditure)	
	Public hygiene, hospitals, insurance, etc.	

CAUSE

VARIATIONS IN PSYCHO-PHYSIOLOGICAL MECHANISM

(*'Deviations from Positive Health'*)

INDICATED BY

Marriage, Fertility and reproduction-rates	Measurement of physique	Morbidity (various diseases)	Mortality (various diseases)	Efficiency records (output, accidents, etc.) and tests
1	2	3	4	5

All the working conditions on the left-hand side of the special industrial fatigue scheme are here grouped under occupation, which may apply to *school* or *work*, either in industry or in the Forces. The effect of unemployment must also be considered. Living condi-

tions take on an increased importance and are given a column to themselves. They may be divided into home life, including the food still customarily taken there, and community services. These services may be preventive, such as are rendered by local medical health officers, curative such as the hospital services, or palliative such as insurance benefits.

In the investigation of industrial fatigue, type and training of workers and their selection to fit their job were found to be important conditions of efficiency (and happiness). It was found to make a difference in the results of, say, hours upon accidents if the workers were men or women, or were experienced or 'green'. Similarly, in any investigation of social conditions it will make a difference on what persons or group of persons the impact of the purely environmental condition falls. As an expansion of 'type' and 'training' of workers a third column is therefore added to the general scheme of study, headed "Persons Affected". Here the influence of nature and nurture (sex, age, heredity, education, experience) upon differences and variations in human health and efficiency and their importance in recruitment of personnel is taken into account. This is the special field of social biology, and its importance suggests that a fully developed school of social medicine should have a special lecturer or readership in social biology attached to the chair.

The indexes and tests of efficiency in the original scheme may be enlarged by the addition of standardized tests of health and survival such as marriage, reproduction and fertility-rates, morbidity and mortality-rates from various causes, and in general. There will, of course, be the same need for laboratory and clinical research into the intermediate psycho-physiological mechanism to interpret how the variable social conditions are associated with variations in these statistically measured external events. One approach, already mooted, is to assume psycho-physiological variations or deviations from some standard of *positive health*.

Many of the social conditions are now directly measurable in statistics already recorded or easily reckoned: under the heading occupation, hours worked and physical conditions; under the heading home life, physical housing conditions, distance from work, degree of urbanization (by population density), family income (largely determining food consumption); under community services, per capita expenditure of central and local authorities; under persons affected, age, period spent at school or in training. The possibilities and limits of such exact information both about social conditions and tests of health and efficiency require a lecturer or readership in demography and social statistics for their elucidation.

Where statistical records are not yet available in sufficient detail or do not answer the relevant question, *ad hoc* inquiries should be made in the field. For example, the constituents of food purchased or eaten by families, the actual extent of specific types of social services performed, the stop watch measurement of the intensity of work, social relations both at the place of occupation and in the home and community. The need mentioned above for exact psychological and anthropological study extends from industrial to all other social groups. Social medicine would indeed be greatly helped by the establishment of lecturers or readerships enabling fieldwork observations to be undertaken in the social psychology or anthropology of factories, schools or indeed typical households. The hospital almoner, for example, constantly comes up against 'case work' problems arising from psychological reactions to work or to family relationships, and needs expert advice. Much of the research work here would be preparatory to statistical measurement. The quality of types of social relationships must be understood before quantitative assessment of each type can be undertaken.

Classical and recent research in social medicine may be briefly reviewed (giving references in brackets) to show how far the lines actually developed fit into the scheme of study outlined above. If occupation (at work or school) and living conditions be lettered A and B, and the five tests of health and efficiency numbered 1, 2, 3, 4 and 5, we can find examples of all possible combinations of variation in one sort of condition A or B with variation in tests 1 to 5. Besides these 'couplings' there are 'triplings', 'quadruplings', and so on, where variations in two or more sorts of condition are related to a test. It is here that the persons affected (column C) come into the picture as influencing the effects of the purely environmental conditions.

Couplings	*All possible combinations*
A and 1	Differential Fertility of Different Occupations (Dr. Enid Charles)
A and 2	Measurements of Height, Weight, Muscular Strength, etc., of Unemployed. (Industrial Health Research Board)
A and 3	Relation of Type of Work to Sickness Absence. (Medical Research Council)
A and 4	Occupational Mortality-Rates. (Registrar-General)
A and 5	Hours of Work and Output, Absenteeism, Accidents, etc. (Health of Munitions Workers Committee) (U.S. Public Health Service)
B and 1	Differential Fertility of Income Classes, Rural and Urban Populations. (Dr. Enid Charles)
B and 2.	Food and Malnutrition Symptoms. (Sir John Orr)
B and 3	Ante-Natal Services and Maternal Mortality. (Ministry of Health (Report 1937))
B and 4	Density of Population and Death-Rates. (Dr. Farr)
B and 5.	Wages and Output. "The Economy of High Wages". (Lord Brassey)

Triplings, etc.	*Scattered Examples*
BC and 4	Infant Mortality by Income Class. (Registrar-General)
AC and 5	Accident Proneness in Factories. (Industrial Health Research Board)
ABC and 5	Retardation of School-children and Poor Homes. (Lloyd and Burt, City of Birmingham)

3. Summary and Conclusions

1. If social medicine is defined as the study of variations in human health and efficiency associated with variations in social living and working conditions, it can be viewed as an extension of studies of industrial fatigue initiated before the War of 1914–18.

2. Such studies, aiming at the scientific observation of social norms of behaviour, can and (where laboratory experiment is impossible) must be based on statistical measurement and summarization. They require full exploration of the possibilities of vital statistics as a measure of health and efficiency as well as statistics of social conditions. A professor of social medicine should have the co-operation of a reader in demography.

3. The social conditions the observation and measurement of which have proved particularly difficult in fatigue studies, and are likely to do so in social medicine, are those relating to psychological social and family relationships. Readerships in social psychology and anthropology would clear up many of the more difficult obstacles in the path of social medicine.

4. Different classes of persons will react differently to similar conditions according to their heredity, sex, age, education and past experience. Such variation due to nature and nurture (apart from present environment) must be studied in a social biology, for which additional provision should be made.

5. A chair of social medicine should thus, in a fully developed school, be supported by a staff that includes experts in demography and social statistics, in social psychology and anthropology, and in social biology.

[1] *Proc. Brit. Assoc.* (1914, 1915).
[2] Florence, "Economics of Fatigue and Unrest", Chap. 4, Table 3.
[3] Florence, "Economics of Fatigue and Unrest", pp. 244–48.
[4] For example, Whitehead, "The Industrial Worker".
[5] Florence, "Economics of Fatigue and Unrest", p. 100.

STRUCTURE OF HETEROCHROMATIN

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IT has long been known that some chromosomes, or chromosome segments, respond to staining during mitosis or meiosis in a different way from the rest of the set. They are called 'heterochromatic' to distinguish them from the 'euchromatic' rest of the set taken as a standard. The cyclic staining reaction of the chromosomes is generally attributed to synthesis, during prophase, and breakdown, during telophase, of desoxyribose nucleic acids—a view recently challenged by Stedman and Stedman[1], but which will be followed here, the substance actually involved being irrelevant for the present discussion. It is now clear, especially from the work of Darlington[2] and his collaborators, that the visible difference between heterochromatin and euchromatin is a consequence of a difference—referred to as 'allocycly'[3]—in the timing and/or in the amplitude of the above cycle. In heterochromatin the maximum nucleic acid charge attained by euchromatin at metaphase may be attained earlier, later, never or even surpassed. This behaviour has been taken as showing that heterochromatin has a lower reactivity in nucleic acid synthesis, and that, therefore, only when the demand for nucleic acid precursors by the more active euchromatin is low can heterochromatin successfully compete for them. It will be seen that another explanation is also possible.

Let us consider the characteristics and behaviour of heterochromatic segments. In the first place, the same segment, or chromosome, may be visibly allocyclic in one tissue and not in another, or it may have different allocyclic behaviour in different tissues. An example of the former type are the sex-chromosomes of many mammals, strongly allocyclic at meiosis but not so at mitosis; and of the latter the *X*-chromosome of the Acrididæ, in which the cycle is shifted one way in certain divisions of the germ track and the opposite way in others[4]. Thus the allocyclic behaviour is determined by at least two factors: the reactivity of the heterochromatic segment itself and the conditions of the cell[3]. As some of the latter can be controlled, what happens in Nature between tissues has been imitated experimentally within one tissue. For example, by low-temperature treatment it has been possible to detect as heterochromatic in mitotic or meiotic metaphase segments that under normal conditions could not be identified as such[3,5].

Secondly, two or more heterochromatic segments in the same nucleus, or even in the same chromosome, often differ from each other, besides differing from euchromatin, in their nucleic acid cycle. A conspicuous example of this is provided by the pairing and differential segments of mammalian sex-chromosomes: both are heterochromatic but with distinct cycles[6]. In this case it is certain that the different cycle goes with different genetical properties.

Thirdly, heterochromatic segments, or chromosomes, have been identified of any visible length. They may be located in any part of the chromosome set. Of course, the greater their length and the stronger their allocycly, the more easily they are detected. Our knowledge of their occurrence in animals and plants is, thus, inevitably a very distorted one.

Fourthly, certain heterochromatic segments in some species have the property of 'non-homologous' association in the prophase of meiosis, or in the polytene chromosomes. This property, however, is of erratic occurrence and tends to occur in groups of related species, rather than at random. This suggests a common origin for a property that, as will be seen later, is by no means a general characteristic of all heterochromatin.

Finally, since the discovery by Muller and Painter[7] of genetically 'inert' chromosome segments, and their identification by Heitz[8] with heterochromatic segments, 'inertness' has been found to accompany allocycly in all unambiguous cases. This 'inertness' manifests itself in two ways. One is that, per unit length, heterochromatic segments carry fewer, or no, genes detectable by sharply alternative effects of different allelomorphs. The other is that deficiencies or duplications for heterochromatic segments have far less harmful effects than deficiencies or duplications for euchromatic segments of the same size. The 'inertness' of heterochromatin may mean that either there are actually few, or no, genes in it, or there are a full quota of genes but the developmental effects of mutation or change in quantity in them are difficult to detect. Recent work[11,12,13,14,15] strongly suggests that the latter alternative is the correct one.

Several trends of thought and lines of research seem to agree in regarding heterochromatin as internally less differentiated than euchromatin. Indeed, this idea was already implicit in Muller's early suggestion that what we now know as heterochromatin originates from mutation towards 'inertness' of genes kept in a permanently heterozygous state, as those of the *Y*-chromosomes. Caspersson[9] and his collaborators consider heterochromatin as "built up of identical or similar elements or genes", a construction that would explain why deficiencies or duplications are so much less harmful than for comparable euchromatic segments. Furthermore, they consider that the greater uniformity of heterochromatin is expressed in the simpler types of proteins which, by means of ultra-violet spectroscopy on salivary gland chromosomes, they found in it. Unfortunately, as the same authors have shown, the types of proteins in the chromosomes change during successive stages of the division cycle, and Painter[10] has discovered that the salivary gland chromosomes undergo a process somewhat comparable to that of mitosis. As heterochromatin and euchromatin have cycles that may not coincide in time, only a comparison covering whole cycles in the same types of cells, and in different species, could show whether the difference in the types of proteins is general and not spurious. Darlington[2] has expressed the idea of the lesser internal differentiation of heterochromatin by saying that the difference between 'activity' (of euchromatin) and 'inertness' (of heterochromatin) is a difference between high

specificity and low specificity. Further, with his collaborators[11,12,26], he has shown that the heterochromatic 'supernumerary' chromosomes, characteristic of many animals and plants, are by no means inert. These 'supernumeraries', though varying in number between cells of an individual and individuals in a population, tend, as noted by Slack[13] in Cimex, towards an equilibrium, which Darlington and his collaborators have shown to be adaptive. Finally, Mather[14,15] has given a concrete expression to the view of the uniform structure of heterochromatin by suggesting that heterochromatin is made up of 'polygenes', and by finding genetical evidence which supports this idea. Study of the genetical and cytological properties of mammalian sex-chromosomes[6] also supports Mather's view.

There seems to be, in conclusion, a considerable amount of agreement for considering heterochromatin as internally less differentiated than euchromatin. On two points, however, the present trend of thought is not equally definite. One is the connexion between this lesser differentiation and the allocyclic behaviour. The other is the question of whether or not the elements that make up heterochromatin are necessarily different from those that make up euchromatin. These two questions will now be discussed.

Let us first consider what makes the nucleic acid cycle of euchromatic regions appear uniform throughout the nucleus. It is proper to raise this question before discussing what makes heterochromatin differ in this respect, because, in fact, during a brief part of the division cycle euchromatic regions are far from uniform along their length. This part is early prophase, especially of meiosis, when nucleic acid has already condensed along the chromosomes but their lengthwise contraction is barely starting. In this short period the chromomeres are distinctly visible and obviously differ from each other in their nucleic acid charge. Each chromomere shows a distinct reactivity of its own in nucleic acid synthesis; it is 'allocyclic' in relation to others, either because its cycle is shifted in time, relative to that of other chromomeres, or because different chromomeres synthesize at different rates or reach different final charges. The giant salivary gland chromosomes of Diptera show this longitudinal differentiation of euchromatic regions even better: their 'bands' present an array of different charges and are intermingled along the chromosomes more or less at random with respect to these charges. As mitosis or meiosis proceeds, the chromosomes contract enormously by spiralization and loss of proteins[9]. Consequently it is no longer possible to distinguish the individual chromomere; all that a chromosome segment can show is the aggregate effect of its component chromomeres. In segments with intermingled chromomeres of different charges, the result is apparently uniform within and between segments. The reaction of euchromatic regions, optically uniform as they are after prophase throughout the whole chromosome set, is, thus, the statistical consequence of their being made up of a mixture of highly differentiated chromomeres. The immediate corollary is that a segment in which chromomeres are more uniform may differ in its aggregate reaction from the former.

If we accept the view that heterochromatin is made up of elements less differentiated than euchromatin, we have only to assume that these elements are chromomeres, and chromomeres of the same type as those which we find intermingled in euchromatin. The essential difference between the two types of chromatin would then lie exclusively in the linear arrangement of chromomeres with the same nucleic acid cycle: a heterochromatic segment being one with a very high proportion of these similar or identical chromomeres. Segments made up of repeated replicas of a single type-chromomere, or few type-chromomeres, would be the extreme term in a series between euchromatin and heterochromatin. Unfortunately, the only case in which, so far, it has been possible to make out the minute structure of heterochromatin in a suitable stage is that of some Dipteran salivary chromosomes. Here each heterochromatic segment actually consists of chromomeres far more uniform than those of the euchromatin; moreover, in Drosophila, some, but not all, heterochromatic segments in a salivary gland nucleus agree in having the same types of chromomeres[16]. The latter feature, however, like that of 'non-homologous' association probably connected with it, is certainly not general.

Clearly the preceding suggestion accounts for the allocyclic behaviour of heterochromatin. In fact, the nucleic acid cycle of the type-chromomere, or chromomeres, making up a heterochromatic segment, will but seldom happen to be identical with the nucleic acid cycle of euchromatin, which is an average. More often it will be distinct, being out of phase or in other ways differing from the latter, just as two 'euchromatic' chromomeres may differ from each other. Furthermore, the type-chromomere, or chromomeres, of each heterochromatic segment need not, and often will not, be the same for different segments, thus accounting for the different allocyclic behaviour of two or more segments in a nucleus. On the other hand, it may be inferred that 'non-homologous pairing' occurs just in those species where these type-chromomeres happen to be the same in more than one segment; in other words, in cases where two or more heterochromatic segments have a common origin, as Prokovjeva[17] and Muller[18] suggest for Drosophila. This would also explain why this property appears erratically but tends to occur in several of a group of related species. Thus allocyclic behaviour can be accounted for by assuming a different linear arrangement of similar chromomeres without need of the further assumption of any difference in the nature of the chromomeres themselves. Can we, on this simple assumption, also account for the functions in cell physiology that are being attributed to heterochromatin?

The main inference is that heterochromatin acts as a regulator of the nucleoprotein metabolism of the cell and therefore controls the reproduction of the chromosomes[2,9,11,19,20]. This function is deduced mainly from consideration of the activity of the nucleolus, and of the disturbances arising in the division of the nucleus as a whole in consequence of excess or defect of heterochromatin, and in the division of parts of the chromosomes in consequence of changes in the relative position of eu- and heterochromatin. Indeed, the weight of part of this evidence would become decisive only if it were established that euchromatin does *not* produce the same effects. However, on the basis of the structure of heterochromatin as proposed here, one would expect each heterochromatic segment to exercise both a localized and a general *specific* effect on the conditions of nucleoprotein synthesis in the nucleus, often different from the *non-specific* effect (in this respect) of any euchromatic segment of comparable length. It is, therefore, permissible to venture a prediction:

namely, that close investigation will reveal very characteristic differences in the action of different heterochromatic segments in the same species, and between species. It is perhaps due to the fact that so much use has been made of Drosophila for the investigation of heterochromatin that this possibility has been overlooked (but see Demerec[27]).

This brings us to speculate upon the origin of heterochromatin. It is implicit in the view expressed here that a heterochromatic segment should arise every time that a minute euchromatic region undergoes repeated reduplications in the genotype and the replicas remain adjacent to each other on the chromosome. Models of some such process are known, and there is every reason to believe that, once a first replica has become established, the mechanical and genetical possibilities of its being repeated are enhanced. The finding by Harland[21] that the same function may be performed in one species by a single gene and in a related species by many is perhaps an example of the genetical consequences of this process. There is, thus, plenty of scope for new heterochromatic blocks to be formed, for old ones to be eliminated, and for variations in size. Furthermore, inversions and other appropriate structural changes may break up an originally compact heterochromatic segment into many small ones interspersed among euchromatin (cf. Kaufmann[22]). Natural selection and accidental variation seem to have a number of possibilities here.

As stressed by Wharton[23] and by White[24], among others, heterochromatin certainly plays an important part in speciation. This part stands out in terms of Mather's[25] theory of polygenic variation. Mather has studied the function of linkage between 'polygenes' (definable perhaps as genes existing in repeated replicas in the genotype) as a basis on which the evolutionary plasticity of a species is founded; he has now reached the conclusion that heterochromatin is made up of polygenes[15]. We see that the formation of new heterochromatic segments, their loss or dispersion and their variation, by the process adumbrated above, are all mechanisms whereby polygenes may arise and linkage between them may be created and varied.

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WORDSWORTH AND SCIENCE

By DR. V. B. WIGGLESWORTH, F.R.S.

To the solid ground
Of nature trusts the Mind that builds for aye;
Convinced that there, there only, she can lay
Secure foundations.

FOR seventy-five years the first lines of this quotation have appeared on the cover of NATURE. For long enough the quotation was inaccurate; not until 1929 and 1934 were the errors brought to the notice of the Editor and put right. When the lines first appeared in this setting, Wordsworth had been dead for nearly twenty years. Had he been alive he could scarcely have approved the use to which his words were put. To the scientific reader of NATURE (after he has permitted himself perhaps a fleeting smile at the *double entendre*) the words may well convey a sentiment gratifying to his self-esteem. But there is little in the sonnet from which they are taken to justify that feeling, and less in Wordsworth's writings as a whole.

In a moment of enthusiasm in 1833, writing of "Steamboats, Viaducts and Railways", Wordsworth cries:

Nature doth embrace
Her lawful offspring in Man's art; and Time,
Pleased with your triumphs o'er his brother Space,
Accepts from your bold hands the proffered crown
Of hope . . .

By 1844, when the railway threatens Kendal and Windermere, the tone has changed:

Is then no nook of English ground secure
From rash assault?

He "scorns a false utilitarian lure".

But it is Wordsworth's abstract reflections on science, when writing at the height of his powers, that we shall take more seriously. His attitude to science is almost uniformly hostile. "All *heaven-born* instincts shun the touch of vulgar sense." In 1806 he writes of the "Star-gazers", the public in Leicester Square who, for the price of one penny, are permitted to glimpse the heavens through a telescope. It is a parable on the ultimate dissatisfaction of those who "pry and pore". The same feelings about science find their most unbridled expression in "A Poet's Epitaph" (1799), where men of many sorts in turn approach the poet's grave. The man of science is greeted thus:

Physician art thou?—one, all eyes,
Philosopher! a fingering slave,
One that would peep and botanise
Upon his mother's grave?

He is besought to take his "ever-dwindling soul, away!"

A more considered variant on this recurrent theme is to be found in Book IV of "The Excursion" (1810–20). Shall those "ambitious spirits" who "have solved the elements, or analysed the thinking principle . . . prove a degraded Race?"—"Oh! there is laughter at their work in heaven!"

. . . go, demand
Of mighty Nature, if 'twas ever meant
That we should pry far off yet be unraised;
That we should pore, and dwindle as we pore,

Viewing all objects unremittingly
In disconnection dead and spiritless ;
And still dividing, and dividing still,
Break down all grandeur . . .
. . . And if indeed there be
An all-pervading Spirit, upon whom
Our dark foundations rest, could he design
That this magnificient effect of power,
The earth we tread, the sky that we behold
By day, and all the pomp which night reveals ;
That these—and that superior mystery
Our vital frame, so fearfully devised,
And the dread soul within it—should exist
Only to be examined, pondered, searched,
Probed, vexed, and criticised ?

His spirit revolts at the ways of men of science, who prize the human soul and the transcendent universe

No more than as a mirror that reflects
To proud Self-love her own intelligence.

In one passage only, of which I am aware, and that still later in "The Excursion", does Wordsworth admit that science may find "its most noble use . . . in furnishing clear guidance to the mind's *excursive* power" and "then, and only then, be worthy of her name":

For then her heart shall kindle ; her dull eye,
Dull and inanimate, no more shall hang
Chained to its object in brute slavery.

Ought we then:

To reinstate wild Fancy, would we hide
Truths whose thick veil Science has drawn aside ?

No ! No matter how high we rate "the thirst that wrought man's fall" . . . "the universe is infinitely wide" and reason will ever meet "some new wall or gulf of mystery" which nothing but "Imaginative Faith" can overleap.

The fact is that Nature for Wordsworth has so deep a meaning.

The sounding cataract
Haunted me like a passion : the tall rock,
The mountain, and the deep and gloomy wood,
Their colours and their forms, were then to me
An appetite.

Perhaps that is as far as most votaries of Nature get. But in these lines Wordsworth, "so long a worshipper of Nature" (and if Wordsworth says "worshipper" he means it) is looking back to his "thoughtless youth" before he had learned to hear in Nature "the still sad music of humanity" and had gained "a sense sublime of something far more deeply interfused . . .", the "soul of all my moral being". Indeed, he goes on almost to reproach his sister that "in the shooting lights" of her "wild eyes" he can read only those more superficial joys. She lacked as yet:

. . . the spirit of religious love
In which I walked with Nature.

It is true that, for a time, depressed and bewildered by the excesses of the Revolution in France and the reactions it provoked, he "turned to abstract science" and there sought

Work for the reasoning faculty enthroned
Where the disturbances of space and time,
. . . find no admission.

But he was soon recalled by Dorothy and "preserved a Poet" to "seek beneath that name alone" his "office upon earth" and to derive "genuine knowledge" from "sweet counsels between head and heart".

Such is a fair picture of Wordsworth's view of science. Whether the poet would have deemed it an act of piety to con and sift his writings in this way, to the sorry detriment of his grand use of words, is open to doubt. He might well have cried :

Our meddling intellect
Mis-shapes the beauteous forms of things :—
We murder to dissect.

To-day, when physics ends in the mists of mysticism, it may be that science might claim kinship with Wordsworth the poet. But science now claims all society as her province, and Wordsworth the prophet and reformer would fit less awkwardly into the pages of NATURE. The Wordsworth who, standing at the threshold of the Industrial Revolution, with a mind not warped by politics, can compare with truly scientific objectivity, though with all a poet's feeling, the evil of the factory child with the grinding penury of rural England and the ignorance and degradation of the children on the land. The Wordsworth who can describe the factories wherein "little children, boys and girls" enter and

where is offered up
To Gain, the master idol of the realm,
Perpetual sacrifice,

and who can yet rejoice

(Measuring the force of those gigantic powers
That, by the thinking mind, have been compelled
To serve the will of feeble-bodied Man)

in the conviction that late or soon man will learn that "physical science is unable to support itself" and that

. . . all true glory rests,
All praise, all safety, and all happiness
Upon the moral law.

The Wordsworth who, surveying all these evils present and to come, finds a solution and a hope (this in 1810) in "a System of National Education established universally by Government" and urges that such a system be begun at once even "when oppression, like the Egyptian plague of darkness" is "stretched o'er guilty Europe". For then

Change wide, and deep, and silently performed,
This Land shall witness.

OBITUARIES

Mr. J. Reid Moir, F.R.S.

I FIRST met Reid Moir so long ago as 1911. Rumours had been flying about that it had been demonstrated without cavil that the Garden of Eden had been close to Ipswich, that mankind's birthday had been thrown back millions of years, that the 'missing link' had been at last found ; that all these startling new discoveries were the result of a Mr. Moir's finds in a gravel pit near Ipswich. The facts were that Moir, in business in Ipswich, instead of playing golf in his spare time, spent all his leisure in the gravel pits near his home in the hope of discovering the relics of

early man. In this he was helped and backed up by the late Sir Ray Lankester, without whose aid even Reid Moir might have failed to 'get his ideas over'. The age of the gravels in question has never been doubted. They contain a rich fauna and belong to a period *antedating* the Cromer Forest bed : in the still current nomenclature they are late Pliocene in date. Moir claimed that *in situ* in these gravels he had found artefacts, that is, flints which had been chipped by man, and which for reasons given could not have been the result of natural operations.

The heat of the controversy which at once burst on Moir's head can only be explained if we remember that theological as well as archæological considerations were involved. The theory of evolution as outlined by Darwin had, it is true, been somewhat grudgingly accepted by the Churches; but here was a little business man in a provincial town who ventured to throw back the antiquity of man to some incredible date, to throw completely out of balance the accepted order of man's history. On no other ground can one explain the fury of the conflict. One of Moir's opponents actually had printed in colour a Christmas card burlesquing the whole theory. But Moir was of Scottish origin and had been hardly brought up by his father, the founder of the tailoring business he was later to inherit. Indeed, he once told me that at first he was made to sweep out the premises in the morning. He just persisted in his theories, collected more and more evidence from the pits, and studied more and more closely the complicated phenomena of flint fracture. Through thick and thin he continued to have the support of Lankester and a small number of scientific men with open minds.

But it was not until 1920 that the great moment came. It must be remembered that prehistory was recognized as a definite subject much earlier on the Continent—more especially in France—than in Great Britain. The two chief exponents there were Profs. Boule and Breuil. Both had written long articles against Moir's ideas. One based his objections on observations of a mortar-making machine at Mantes, the other on some finds of flints flaked as a result of earth pressure. It was in 1920 that Moir discovered certain chipped flints which seemed to him conclusive, and he sent them to the Sedgwick Museum at Cambridge for consideration. The late Prof. J. Marr called me in for consultation and as a result I invited the Abbé Breuil to come to Cambridge at once, which he did. I took him over to Ipswich, and a long afternoon was spent poring over the finds spread out over the floor of Moir's study. Breuil said little, and when driving back in the evening he was still more silent. Then he quietly remarked, "Mon cher ami, aujourd'hui a beaucoup vieilli l'humanité". It was a magic moment ! In the following year he announced his change of ideas at an international congress held at Liège. That each and all of the specimens Moir claimed as humanly fashioned were really artefacts may be doubted : that tool-making animals, almost certainly therefore primitive humans, existed at that remote period is, however, a fact accepted to-day by the vast majority of prehistorians. This is Moir's great work, for which he was eventually awarded a fellowship of the Royal Society.

It would take too long to describe in detail all the investigations Reid Moir undertook in the Ipswich district and elsewhere. Some proved to be important and the results were accepted by the scientific world ; others proved less so, and the explanations put forward at the time had later to be modified. But this is true for any active investigator in the field. Moir was generous with the specimens found in the course of his excavations, and these are now widely distributed in the museums of England and France ; but his first loyalty was to the well-known Ipswich Museum, of which he was the godfather, having, in fact, made it what it is to-day. At the time of his death, he had been studying certain finds made long ago in the Puy Courny district of France. It is to be hoped that his notes are extant. The drawings were already made some considerable time ago ; but the War stopped all idea of publication on a scale necessary for such a work.

Moir was interested in many things besides prehistory, and I have letters of his philosophizing on life generally. He had a soft heart and was much concerned that the slaughter of animals for food should be painless. Indeed, he inaugurated a local campaign to this end. To gain time for his many scientific commitments and interests, he turned his business into a company and as such it did not prosper too well. In fact Moir, in the latter part of his life, was an exceedingly poor man as a result of his scientific toil. He was interested in water geology and took this matter up professionally to some extent. As was to be expected, Moir in his younger days in the heat of controversy could be fierce. I have had letters from him which I promptly burnt ! Nevertheless, his characteristic and ferocious brand of language was part of his robust personality, which never shirked a challenge, and indeed helped to endear him to many of us. But there was a lovable strain right through him, and this, together with his charm of manner, in later years took a more and more prominent place in his nature. I can only add that personally I had a real affection for Reid Moir and sincere regrets that he has gone. This emotion, I am convinced, will be shared by everyone who knew him well. Miles C. Burkitt.

Dr. L. H. Baekeland

In the passing of Dr. Leo H. Baekeland on February 23 in his eighty-first year, the world of applied science has lost an outstanding man. He was an individual of outstanding character with a high moral status and charming personality. One never tired of hearing his stories of his adventures connected with his travels to most lands and his yachting experiences. He lived to see and to gain the benefit of his two great developments, namely, 'Velox' gaslight paper and 'Bakelite' synthetic resins. Of late years he had been in failing health, and the chemical and technical societies of the United States and Great Britain have missed his presence at their annual meetings for about eight years.

Baekeland was born in Ghent on November 14, 1863. He studied science in the University of his birthplace, making chemistry his chief subject, and afterwards became a lecturer in the University. In 1884 he graduated as a doctor of science at the University of Ghent. Although he was not yet twenty years of age he became professor and taught chemistry at the University from 1882 until 1889, and during 1885–89 he taught both chemistry and physics at the State College of Science, Bruges. During this period he also went to Germany, meeting German men of science and learning their language.

He married Miss Celine Swarts, the daughter of

his professor of chemistry, in 1889, and at the end of the same year he emigrated to the United States of America.

In the United States Baekeland devoted the earlier part of his career to research work which resulted in his discovering a process for the production of photographic printing paper, suitable for use in artificial light. To these papers he gave the name 'Velox', which printing paper is still well known throughout the world. In 1893 he founded the Nepera Chemical Co., and in 1898 he sold his interest to the Eastman Kodak Co.

Afterwards, at the age of thirty-five, he returned to research work in a laboratory in a house at Yonkers, near New York, where he worked on various chemical problems, including those connected with resinous products, and made a study of the reaction between phenol and formaldehyde. In 1907 his United States patent on the process for producing phenolformaldehyde resins under control was filed, and this patent became world-famous. In 1909 he read a paper on "The Synthesis, Constitution and Uses of Bakelite" before the New York Section of the American Chemical Society, in which he described in considerable detail the researches which led up to this patent.

In 1910 the Bakelite Gesellschaft was founded in Germany; six months later the General Bakelite Company of America was founded, both companies being for the large-scale production of phenolic resinous materials, known as 'Bakelite' materials. The latter company with the Redmanol Chemical Products Co. and the Condensite Co. of America was afterwards merged into the Bakelite Corporation, of which Dr. Baekeland was the president in 1922.

It was due to Dr. Baekeland's fine personality, initiative and far-sightedness that Bakelite Ltd. in England was formed by an amalgamation of interests which were active in the synthetic resin field.

Many honours were bestowed upon him. He was a commander of the Belgian Order of Leopold, an officer of the Order of the Belgian Crown and an officer of the Order of the French Legion of Honour. For many years he was president of the American Chemical Society. The W. H. Nichols Medal was presented to him in 1909; in 1910 he received the John Scott Medal of the Franklin Institute, and in 1913 he received the Willard Gibbs Medal. When he belonged to the Instruction Board of the Columbia University, he was presented by that University with the Chandler Medal. He was an active member of the Society of Chemical Industry, which in 1916 presented him with the William Perkin Medal of the New York Section of the Society of Chemical Industry. In 1915 he was made a doctor of chemistry *honoris causa* of the University of Pittsburgh. He was also president of the American Institute of Chemical Engineers and of the American Electrochemical Society. In 1938 he was presented with the Messel Medal of the Society of Chemical Industry.

Dr. Baekeland was a member of the U.S. Naval Consulting Board since 1915, a member of the U.S. Nitrate Supply Commission in 1917, and chairman of the Committee on Patents of the National Research Council. He was also a trustee of the Institute of International Education since 1919, and a member of the Advisory Board of the Chemical Division of the U.S. Department of Commerce since 1925.

WE regret to announce the following deaths:

Sir Colin Fraser, director of materials supply of the Australian Department of Munitions and chairman of the Commonwealth Minerals Committee, and a past president of the Australian Institute of Mining and Metallurgy, on March 10, aged sixty-eight.

Prof. A. E. Jolliffe, emeritus professor of mathematics in the University of London King's College, on March 17, aged seventy-three.

Dr. A. W. Pollard, formerly keeper of printed books in the British Museum and honorary secretary of the Bibliographical Society, on March 8, aged eighty-four.

Sir David Prain, C.M.G., C.I.E., F.R.S., lately director of the Royal Botanic Gardens, Kew, on March 16, aged eighty-six.

NEW FELLOWS OF THE ROYAL SOCIETY

THE following were elected fellows of the Royal Society on March 16:

BRIGADIER R. A. BAGNOLD, explorer; distinguished for scientific work on desert topography, and in particular for his precise studies of the physical principles governing the movements and deposition of sand under the action of wind.

MR. R. P. BELL, fellow of Balliol College, Oxford; distinguished for his theoretical and practical contributions to physical chemistry, particularly the studies of reaction rates in solutions, and the applications of wave-mechanics.

DR. C. R. BURCH, research physicist, University of Bristol; distinguished for original research in many branches of applied physics, particularly on the methods for attaining high vacua.

PROF. SUBRAMANYA CHANDRASEKHAR, associate professor in the University of Chicago, formerly fellow of Trinity College, Cambridge; distinguished for his contributions to theoretical astronomy and astrophysics, particularly relating to stellar structure and the dynamics of stellar systems.

MR. G. E. R. DEACON, member of the scientific staff of the "Discovery" Committee of the Colonial Office; distinguished for outstanding work, particularly in the Southern oceans, on physical oceanography and marine zoology, and the relations between them.

SIR JACK DRUMMOND, professor of biochemistry, University College, London, and chief scientific adviser to the Ministry of Food, distinguished for his work on practical nutrition.

DR. A. T. GLENNY, immunologist, Wellcome Physiological Research Laboratories, Beckenham, distinguished for his work on immunity and its application to the immunization of man and animals, especially against diphtheria and tetanus.

DR. R. G. HATTON, director of the Fruit Research Station, East Malling; the pioneer of scientific pomology in Great Britain; the research work which he has organized and directed in this field has a world-wide reputation.

PROF. R. D. HAWORTH, professor of chemistry, University of Sheffield; his contributions to the

structure of natural products are of outstanding importance, and by his synthetical investigations he has added greatly to our knowledge of the lignans.

DR. W. O. KERMACK, research chemist at the Royal College of Physicians, Edinburgh; distinguished especially for his contributions to the knowledge of alkaloids and of synthetic therapeutic compounds; and also for his original contributions to mathematics and statistics in subjects of medical interest.

DR. FRANKLIN KIDD, superintendent of the Low Temperature Research Station, Cambridge; he has made important contributions to the study of respiration of fruits and is well known for his work on the gas storage and low-temperature conservation of apples.

PROF. B. A. MCSWINEY, professor of physiology. St. Thomas's Hospital, University of London: distinguished for his researches on the afferent nerves from the viscera and on the control of visceral movements.

PROF. G. F. MARRIAN, professor of medical chemistry, University of Edinburgh; distinguished for his work in biochemistry, especially on the female sex hormones and related substances.

PROF. M. POLANYI, professor of physical chemistry, University of Manchester; distinguished for his fundamental work on elementary reactions, for his theory of chemical activation energies and for many other important contributions to physics and chemistry.

MR. A. SAND, comparative physiologist, Marine Biological Station, Plymouth; distinguished for his studies of the respiratory mechanisms of invertebrates, the pigmentary effector system of reptiles and the sense organs and locomotor mechanisms in fishes.

SIR WILLIAM STANIER, chief mechanical engineer, L.M.S. Railway, scientific adviser to the Minister of Production; distinguished as a locomotive engineer and particularly for his services in the application of science to mechanical engineering.

DR. C. J. STUBBLEFIELD, senior geologist, Geological Survey of Great Britain; distinguished for his knowledge of the invertebrates of the earlier geological formations; especially for his researches on the life-history, classification and migration of trilobites, and the inter-relationships of graptolites.

DR. O. W. TIEGS, zoologist, University of Melbourne; distinguished for his histological and physiological work; in particular for his studies on the embryology and metamorphosis of insects.

DR. H. J. VAN DER BIJL, director of war supply, Union of South Africa; research physicist; distinguished for his electrical researches, particularly on the conduction of electricity through gases, and for his services with regard to the application of science to industry in South Africa.

MR. J. H. C. WHITEHEAD, University lecturer and fellow of Balliol College, Oxford; distinguished for his varied contributions to pure mathematics, particularly in combinatorial topology, the theory of groups and of group-rings.

NEWS and VIEWS

University of Edinburgh: Chair of Public Health

THE University Court of the University of Edinburgh, in appointing Prof. F. A. E. Crew to the Bruce and John Usher chair of public health, has made an interesting and significant break with tradition. Prof. Crew's association with the University, as teacher and research worker, began in the Department of Zoology and continued in the Institute of Animal Genetics, of which he became the first director in 1921, and the first occupant of the Buchanan chair of animal genetics in 1928. In the Institute he gathered about him a notable band of scientific workers from many nations, and these he inspired with his own enthusiasm, so that a steady stream of the results of research in various directions issued from the laboratories. Prof. Crew's transference from animal genetics to public health indicates a change of outlook in health teaching in relation to the populace. In place of emphasizing, as established courses of instruction have done, aspects of control of infection and the improvement of health by better methods of sanitation and environmental conditions in general, the new outlook, from a biological background, envisages a drive for positive health education backed by tuition in social biology and social medicine.

It is obvious that such development of a biological background in public health education cannot entirely take the place of the detailed knowledge of methods of promoting public sanitation and hygiene, which formed a main part of the established and well-tried course, and of which Prof. P. S. Lelean, who is about to retire from the chair of public health in the University, was so capable and thorough-going an exponent. Advantage has therefore been taken of the excellence of the public health services to enlist their aid, and by arrangement between the University and the Corporation of Edinburgh, the Medical Officer of Health, Dr. W. G. Clark, and the staff of the Public Health Department, will collaborate in that part of the course which deals with the application of science to the control of infectious diseases, to public sanitation and to environmental hygiene. Thus it is hoped to develop a comprehensive curriculum in health and social medicine, to which other specialized departments of university study may make their own individual contributions.

Research Workers in Industry

IN the second of the series of addresses on science and industry to the Manchester Chamber of Commerce, delivered on March 16, Dr. A. P. M. Fleming spoke on "Research Workers: Their Education and Place in Industry". Dr. Fleming pointed out that there are only two broad types of research workers: those engaged in pursuit of knowledge for its own sake; and those engaged in applying new discoveries to useful purposes. The latter bridge the gap between the investigations of the fundamental research worker and industry, and Dr. Fleming stressed the importance of such workers having some industrial experience appropriate to their scientific studies although the training required may differ in different industries. In chemical industry, for example, a post-graduate course in an advanced field of chemistry might be followed for a few years before entering an industrial laboratory. An engineer might be advised to leave the university on graduation and spend a

year or two as an apprentice in an engineering firm with a research organization: when he had thus acquired a knowledge of works organization and the character of its problems, he would proceed to the research laboratory, while if he showed unusual ability for research and special capacity in a particular field, he should return to a university, at home or abroad, where there are special facilities for advanced study in that field. Such plans are only practicable in large organizations with established research facilities, but as an alternative method of training use might be made of the facilities of the research associations, on the lines of the plan developed by the Cotton Research Association, for suitable technically trained men from the industry to spend time in the Association's laboratories and then return to posts in the textile industry. Dr. Fleming remarked in this connexion that the industrial research worker should realize he is something of a missionary and use patience and skill in the application of his work, for it is still difficult in some industries to arouse an appreciation of what science can do to assist the manufacturer.

THE fact that Great Britain is still a country of small manufacturing concerns is a particular difficulty, resulting too often in failure to utilize results already being obtained in research, which the research associations might assist to overcome; though it is important that each small company should have on its staff at least one technically trained officer able to translate and make effective all the appropriate new knowledge provided, for example, by the research association of the industry concerned. While the number of research workers in Great Britain is too small, we can hold our own at all times as regards the quality of research, and Dr. Fleming believes the position is more satisfactory than some of the recent comparisons with research activity in the United States and the U.S.S.R. suggest. Numbers may be more important in the future as industrial problems are undertaken by mass attack, and we must encourage a scientific attitude of mind throughout industry and ensure that our technicians and artisans adopt that attitude of mind and mobility and skill which will enable them to turn new developments to account quickly. Scientific advisers to boards of directors of industrial companies might play an important part, since one of the greatest difficulties in many industries is to get into operation quickly an entirely new type of product for which the existing manufacturing facilities are not fully suited.

Royal Institute of Chemistry

AT the sixty-sixth annual general meeting of the Royal Institute of Chemistry held on March 15, Prof. Alexander Findlay made the formal announcement that the style Royal had been added to the title of Institute. The honour was one which, he said, the Institute accepted for the whole profession. Chemists are proud of what they are able to do in the war effort and no less proud of their achievements in advancing the science of chemistry by research, in promoting industrial prosperity, and in promoting and protecting the health of the people by safeguarding the purity of their food and water supplies and by the production of essential vitamins and drugs. The roll of the Institute has increased during the past year by 462 fellows and associates and by 112 registered students. Representatives of the Institute have served on many bodies dealing with questions of public interest, as well as on those directly affecting the profession of chemistry; with the Joint Council of Professional Scientists consideration has been given to problems which will arise in connexion with the further training and the placing in employment after the War of chemists whose normal careers have been interfered with by national service. Other representatives have taken an active part in the work of the Parliamentary and Scientific Committee, which has published a valuable Memorandum on Research and the Universities.

In the post-war world the calls made on the special knowledge and ability of chemists will be greater even than in the past and, if our industrial prosperity and material welfare are to be ensured, a determined and persistent effort will need to be made by Government Departments, by industry, and by the universities and technical colleges to pull level with our chief industrial rivals. The attitude not only of industrial firms but also of the community as a whole towards science must be changed and the scientific habit and a spirit of trust in science must be cultivated. Prof. Findlay also referred to the Chemistry Education Advisory Board and its report on the education and training of those who enter the profession of chemistry through the secondary schools and the universities (see p. 353 of this issue). The Sir Edward Frankland Medal and Prize for registered students of the Institute has been awarded to Dudley Rhoden Scarffe, of the Imperial College of Science and Technology, for his essay on "Introduction of the Chemist to the Public". Prof. Alexander Findlay was re-elected president of the Institute for the ensuing year.

English Education As It Is

THE Education Bill, the main provisions of which have received considerable attention in NATURE, in anticipation of the parliamentary debates, continues to occupy much public attention. The discussion in the House of Commons drags its slow length along, and on the day when the Bill becomes an Act, everything it provides for will remain to be done. Until that day, and in many respects long after that day, English education is unchanged. It is therefore important that all interested persons should know clearly what most people know more or less vaguely—how precisely it stands with English education in its various stages and phases. For that reason we regard it as a happy inspiration on the part of the Royal Society of Arts to secure the services of Mr. P. R. Morris, director of education for Kent, and now in special charge of army education, to lecture on this subject, under the chairmanship of Mr. R. A. Butler. Very few people have the requisite knowledge and experience and vision to describe exactly the present position in regard to elementary and secondary schools, public and private preparatory schools, and the extraordinary variety of 'the adult stage', and Mr. Morris is one of those people. Perhaps his most valuable contribution lies in what he has to say about the adult stage, including first the universities; secondly, "the field known by the rather dreary name of Further Education"; thirdly, the field now known as adult education, with its great achievements in quality and its "appalling inadequacy in quantity"; and lastly, the institutions for the training of teachers, a major issue in the coming educational revolution. Mr. Morris's paper has been published in full in the December number of the *Journal of the Royal Society of Arts*.

British Council Representative for China

THE British Council has appointed Prof. P. M. Roxby, professor of geography at the University of Liverpool and a specialist on Far Eastern matters, to be its principal representative in China. He will take up his duties in the early part of 1945. Prof. Roxby has visited China on three occasions: during 1912–13 as Albert Kahn Travelling Fellow; during 1921–22 as a member of the China Education Commission; and in 1931 as a member of the British group of the Institute of Pacific Relations. His works on China include "The Far Eastern Question in its Geographical Setting", "China as an Entity: The Comparison with Europe", "The Terrain of Early Chinese Civilisation", "China" (Oxford Pamphlets on World Affairs), and contributions on China in the Encyclopædia Britannica. Prof. Roxby's wife, who is lecturer in history at the University of Liverpool, will accompany him to China. With Prof. Roxby's appointment the British Council hopes to be able to expand its work in China, in co-operation with the Chinese authorities. Many valuable activities are already in progress there, particularly in the scientific field, under the direction of Dr. Joseph Needham, who went out to China for the British Council in October 1942.

Summer Schools in Health Education

THE Central Council for Health Education intends holding two Summer Schools during 1944. One will take place at Whitelands College, Bede College, Durham, during July 24–August 3, and the other at Chelsea Polytechnic, London, during August 9–19. The programme of the schools will cover all aspects of health education (including sex education) and should be of value to teachers, youth leaders, educational and medical administrators, nurses and health visitors, social and industrial welfare workers, etc. The mornings will be devoted to lectures which will lay the necessary foundation of basic knowledge, while the evening lectures will relate this knowledge to a wider philosophical, historical and social context. In the afternoons there will be demonstrations and discussions arranged by the various organizations specializing in different fields of health education, and seminars for students with particular interests. Many applicants had to be rejected from the 1943 School owing to lack of accommodation. Those wishing to receive early notification of the forthcoming schools should send their name and address on a postcard to the Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1.

Summer School in Social Biology

THE British Social Hygiene Council will be holding a Summer School in Social Biology at the University College of North Wales, Bangor, during August 19–September 2. The theme of the School will be "Social Biology and the Extra School Year". It is planned to throw light upon the aims and content of biology in the school curriculum, with special reference to the coming increase in the school-leaving age. While primarily intended for those responsible for pupils aged 11–15, the School is designed to appeal to all types of teachers, and to people who are interested in education and social questions generally. The morning instructional lectures will be given by a team of experienced lecturers who have assisted at similar summer schools in the past. The evening meetings will be reserved for the addresses of distinguished scientific and social workers upon the broader applications of biology to human life and culture. In keeping with the lecture programme, demonstrations in practical biology will be arranged to suit the needs of teachers working under school conditions. For those who require it, training in the dissection of common animal types will be given. Times will be set aside for seminars and discussions. Further information can be obtained from the British Social Hygiene Council, Tavistock House South, Tavistock Square, London, W.C.1.

The Night Sky in April

FULL moon occurs on April 8d. 17h. 22m. U.T., and new moon on April 22d. 20h. 43m. The following conjunctions with the moon take place: April 3d. 14h., Jupiter 0·1° S.; April 21d. 11h., Venus 3° N.; April 26d. 12h., Saturn 2° N.; April 28d. 09h., Mars 3° N.; April 30d. 21h., Jupiter 0·4° S. The following occultations of stars brighter than magnitude 6 take place: April 5d. 22h. 26·8m., 308 *B* Leon. (*D*); April 6d. 22h. 51·7m., *b* Virg. (*D*). The times refer to Greenwich and *D* refers to disappearance. Mercury attains its greatest eastern elongation on April 12. The planet sets at 19h. 51m., 20h. 51m. and 19h. 42m. at the beginning, middle and end of the month and can be seen as an evening star, but is not very well placed for observation. Venus rises at 5h. 13m. and 4h. 20m. at the beginning and end of the month and can be seen as a morning star. Mars sets at 1h. 58m. and 1h. at the beginning and end of the month and can be seen in the early part of the night. Jupiter sets at 4h. 10m. and 2h. 15m. at the beginning and end of the month, and is stationary on April 13. Saturn sets at 0h. 46m. and 23h. 04m. at the beginning and end of the month. The Lyrid meteor shower is active from April 18–22. These meteors are due to the debris of Comet Thatcher (1861 i).

Announcements

THE Royal Society, from the income of a fund bequeathed to it by the late Edward Thomas Browne for the support of marine expeditions and of pure marine research work, has placed the sum of £1,000 at the disposal of the Allied Control Commission, to be used in the present emergency for the maintenance of the staff and equipment of the Zoological Station at Naples.

THE Society of the Sigma Xi, the well-known American scientific society, founded at Cornell University in 1886 for the "encouragement of Original Investigation in Science, Pure and Applied", with local members organized as chapters or clubs in some hundred and twenty-five American universities and colleges, is extending its activities to non-academic research institutions which qualify because of their participation in, and encouragement of, original research in science. The first industrial research group to qualify and be granted affiliation with Sigma Xi is the Esso Research Club, of Elizabeth, N.J., the membership of which is drawn from the chemists, physicists, engineers and other technical research and development personnel of the companies associated with Standard Oil Company (N.J.).

ERRATUM.—In NATURE of March 11, p. 319, paragraph on "Meiosis in the Striped Hamster", the number of chromosomes should be $2n = 14$, not $2n = 24$ as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Radioactivity in Osmium

CURRENT theory of the stability of atomic nuclei indicates that two neighbouring isobars, that is, two nuclei with the same mass number and with nuclear charges differing by one unit, should not both be stable, but that the nucleus of higher energy should undergo radioactive change and transform into the other.

There exist, however, five pairs of neighbouring isobars in which both members of the pair are apparently stable. There are two ways in which this may be explained. Either we may assume that the difference of energy between the two nuclei of the pair is too small to allow a radioactive change, that is, to permit the formation of a neutrino, or we must suppose that the radiation which is emitted by one of them has hitherto escaped detection.

The first explanation leads, as Bethe and Bacher[1] have shown, to the result that the mass of the neutrino must be about one fifth of the electronic mass. From other evidence, this seems improbable and consequently the explanation is suspect.

There are three possible types of change: (1) the emission of a negative electron by the nucleus of lower charge; (2) the emission of a positron, or (3) transformation by electron capture of the isobar of higher charge. Bethe and Bacher have pointed out that the first two processes should not be difficult to detect, for the rates of transformation, calculated on the basis of known energy differences between the isobars, should bring them well within the limit of

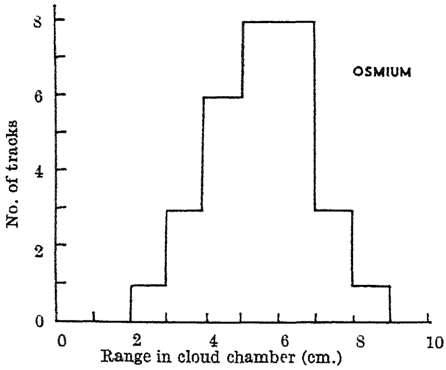

FIG. 1.

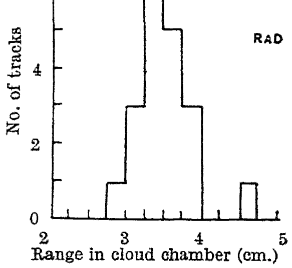

FIG. 2.

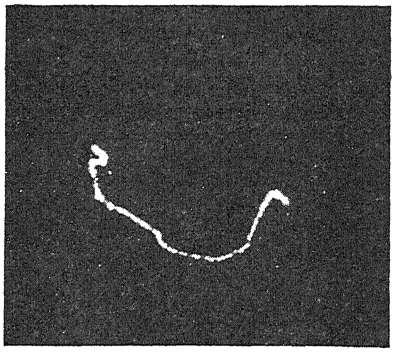

FIG. 3. AN ELECTRON TRACK, 5·1 CM. LONG, RECORDED IN THE CLOUD CHAMBER CONTAINING OSMIUM METAL.

ready observation. It seems, then, that since electron capture would be difficult to detect, process (3) is the most probable explanation of the facts.

A systematic examination of the pairs of neighbouring isobars was begun in this laboratory some time ago; but only in one case, that of osmium, has any definite evidence of transformation been obtained. The osmium isotope of mass 187 (abundance 1·64 per cent) is isobaric with a rhenium isotope (abundance 61·8 per cent), so that on the hypothesis outlined above we might expect a sample of osmium to emit K-radiation of rhenium as a result of the capture of a K-electron. The rhenium K-radiation has an energy of 59 keV. and would give a photo-electron of range about 5 cm. in air. This is convenient for measurement in an expansion chamber; on the other hand, the absorption coefficient of the X-rays is so small (half-value thickness 30 metres in air) that the chance of conversion in the chamber is very small.

A layer of finely divided osmium metal was spread on a tray 20 cm. × 6·5 cm., which was placed in the large expansion chamber described by E. J. Williams[2]. Nearly three hundred photographs were taken, and on these, thirty electron tracks of short range, which started in the gas, were observed. The distribution in range of these tracks is shown in Fig. 1, and it suggests a definite group of electrons of mean range in air, corrected to 15° C. and 760 mm. pressure, of 5·0 ± 0·5 cm. The energy of the electrons was estimated by photographing the photo-electron tracks due to the 47·2 keV. γ-radiation of radium D under similar conditions of operation of the expansion chamber. The distribution of these tracks is shown in Fig. 2, giving them a mean range of 3·0 ± 0·25 cm. in standard air. Assuming that in this region the energy is proportional to the square root of the range[3], this experiment gives an energy for the osmium radiation of 61 ± 6 keV., in good agreement with the energy of the rhenium K-radiation.

With such an extended source it was difficult to assess accurately the half-value period of the activity, but it is possible to make a rough estimate from the geometry and sensitive time of the chamber. The value is 3×10^8 years, but this may be inaccurate by so much as a factor of ten. Attempts, by Dr. J. Rotblat and Mr. D. G. E. Martin, to detect the activity in a Geiger counter were inconclusive and set a lower limit to the half-value period six times greater than the above value. It is interesting to note that Scherrer and Zingg[4] also examined osmium with a Geiger counter and found a small effect which they attributed to impurity.

We wish to thank the Mond Nickel Company, which lent the pure osmium powder.

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S. ROWLANDS.

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Feb. 16.

[1] Bethe, H. A., and Bacher, R. F., *Rev. Mod. Phys.*, 8, 198 (1936)
[2] Williams, E. J., *Proc. Roy. Soc.*, A, 172, 194 (1939).
[3] Klemperer, O., "Einfuhrung in die Electronik", p. 272.
[4] Scherrer and Zingg, *Helv. Phys Acta*, 12, 283 (1939)

Banded Meson Spectrum and the Rossi Second Maximum

A VERTICAL counter telescope, designed on the basis of Bhabha's method[1], was set up as shown in Fig. 1. 5·25 cm. of lead used in positions II and III together absorb all but the very high-energy electrons. Such high-energy electrons produce showers in the lead in position II and are cut out from being counted by the shower particles tripping the anti-counters 4 or 5 or both. The effect of side showers on this counter telescope is found experimentally to be negligible[2]. The fact that this arrangement measures the hard component only has also been experimentally verified[2].

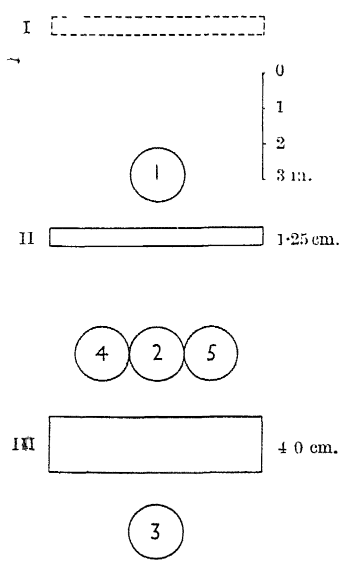

Fig. 1. COUNTERS 1, 2 AND 3 ARE IN COINCIDENCE. COUNTERS 4 AND 5 ARE CONNECTED IN PARALLEL AND IN ANTI-COINCIDENCE WITH COUNTERS 1, 2 AND 3.

The absorption of mesons was measured by placing lead in position I. This is not objectionable, as it is known that penetrating non-ionizing cosmic rays form a negligible portion of the total intensity[3]. The results obtained after taking every possible care to test the counters, circuits, etc., at the end of each measurement are shown in the accompanying table and graphically in Fig. 2.

There is an abrupt drop in the total intensity between the points *A* and *B* on the graph, that is, when the total amount of lead increases from 21·05 to 23·7 cm. This drop is outside the limits of statistical error of the measurements. The slope of the curve before and after the abrupt drop is the same. The drop in intensity, therefore, appears to be real and

Lead in position II = 1·25 cm. Lead in position III = 4·0 cm.

Lead in position I	Counts	Time in hours	Counts/hour
—	7680	81	94·8 ± 0·72
5·2 cm.	4826	52	92·8 ± 0·89
9·3 „	6905	76	90·8 ± 0·73
13·7 „	5430	61	89·0 ± 0·81
15·8 „	3175	36	88·2 ± 1·05
18·45 „	4030	48	84·0 ± 0·89
21·45 „	2581	31	83·3 ± 1·10
24·45 „	3948	48	81·5 ± 0·88

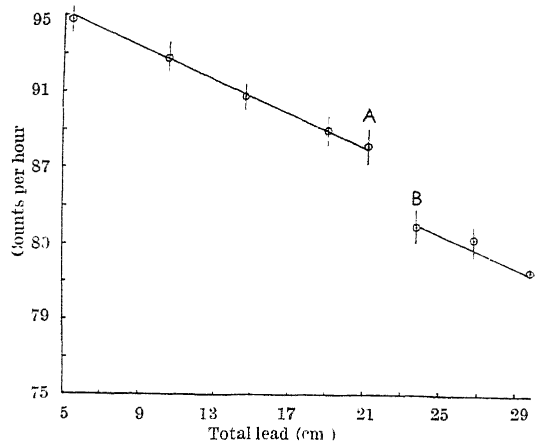

Fig. 2.

not spurious. It occurs when the thickness of lead above the counters 4, 2 and 5 lies between 17·05 cm. and 19·7 cm. This is the region in which the well-known Rossi second maximum has been observed by those who get it[4]. Such a drop in the meson absorption curve has not so far been reported by anybody to my knowledge; but its appearance in this experiment is due to the use of the counter arrangement based on Bhabha's method, which is such as to bring out any existing discontinuities. The interpretation of this experiment, together with the results of further experiments now in progress, will be given in a paper with Prof. Bhabha.

I desire to thank Prof. H. J. Bhabha for his interest and encouragement.

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[1] Bhabha, *Proc. Ind. Acad. Sci*, A, 19, 23 (1944).
[2] In the course of publication.
[3] Jánossy and Rochester, *Proc. Roy. Soc.* A, 181, 399 (1943). Rossi and Regener, *Phys. Rev.*, 58, 837 (1940).
[4] See *Proc. Roy. Soc.*, A, 180, 220 (table I) (1942).

Base Electrolytes for Use in Polarographic Determinations

IN the course of recent research on the application of the polarographic method to the routine analysis of magnetic materials of the 'Permalloy' type, we have found several new base electrolytes which offer considerable advantages for quantitative polarography. They are characterized by the very satisfactory shape of the 'waves', in general free from disturbing maxima, which they yield with a number of metal ions.

Our main problem at the commencement of this work was the determination of iron (12–18 per cent) and molybdenum (2–5 per cent) in the presence of more than 70 per cent nickel and some copper, manganese, etc. We have succeeded in devising and applying our methods to give extremely rapid and accurate routine determinations of these elements in particular, so that to date some six thousand individual determinations have already been made, with a considerable saving of time.

The sample is dissolved in a sulphuric acid–nitric

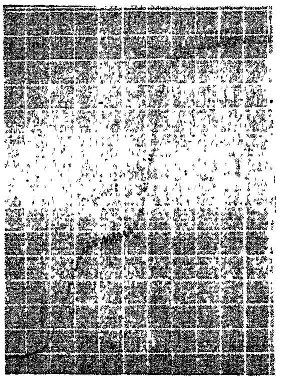

FIG. 1.

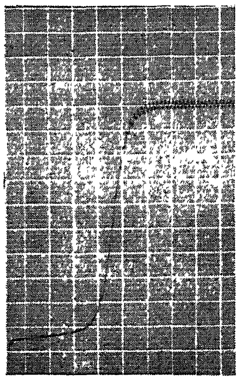

FIG. 2.

acid mixture and made up to a definite volume with distilled water. Aliquots of this mother solution are used in the separate estimations of iron and molybdenum. In the determination of the last-named element, it has been found necessary to remove all traces of nitric acid by heating the aliquot to fumes of sulphur trioxide. After diluting with water and transferring quantitatively to a volumetric flask, the base electrolyte is added and the solution made to volume with water. This base electrolyte is a mixture of citric acid and sulphuric acid chosen so as to give a final concentration in the solution of approximately 0·5 molar and 0·75 *N*. respectively. Under these conditions, molybdenum yields two waves with half-wave potentials $-$ 0·35 volt and $-$ 0·85 volt versus the sulphate electrode (Fig. 1). Since iron and copper are also electro-reduced and interfere with the first wave, we have made use of the second wave. We have observed a deterioration of the wave when the drop time of the capillary in this solution is less than 2·5 sec. at zero applied potential. The *m* value of the hand-drawn capillaries which we use is of the order of 1·6 mgm.sec.$^{-1}$.

In the presence of the other alloying elements in 'Permalloy', we could not determine accurately the iron content by any polarographic method with which we were familiar, but by adding triethanolamine to an aliquot of the mother solution, very useful current/voltage curves were obtained. Some slight advantage was obtained by the addition of ammonia and ammonium chloride, so that the final concentration of the base electrolyte which we employ is triethanolamine 0·3 M; NH_4OH 1·0 M; NH_4Cl 0·85 M. The iron is reduced in two stages in this medium $Fe^{+3} \rightarrow Fe^{+2}$, $E\frac{1}{2}$ $-$ 0·5 volt vs. the S.C.E. (Fig. 2), which is the wave employed in this method, and $Fe^{+2} \rightarrow Fe$, $E\frac{1}{2}$ 1·6 volts vs. the S.C.E. Copper interferes to some extent with the iron wave in this medium, and a rough preliminary separation is necessary in those alloys which contain copper.

These results have led us to study further the ethanolamines as complex-forming agents which can be used, either alone or in conjunction with inorganic salts, as base electrolytes. Some preliminary work has also been started on related organic amines. It appears that these reagents constitute a new and valuable class of base electrolytes.

The properties of the amines can be considerably modified by adding sodium (or ammonium) hydroxide, chloride, sulphate, etc., to achieve separation, suppression or shift of the waves corresponding to various metal ions. It appears as if these electrolytes will be of great use for determining, *inter alia*, iron, copper, nickel, lead, cadmium, barium, cobalt and zinc. Some work has also been started which seems to indicate that aqueous ammonium acetate has a distinct advantage in certain quantitative determinations, notably cobalt, lead, manganese, cadmium, nickel, copper and zinc.

We hope to be able to publish a full account of this work at a later date.

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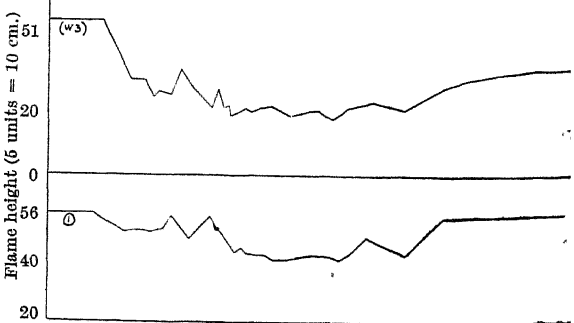
Simple Sensitive Flames

MANY years ago a communication of mine on this subject appeared in NATURE[1]. My interest at the time was only in producing a simple detector of sound waves, but as one of the jets I then prepared was afterwards used by Dr. G. Burniston Brown in his investigation of the properties of sensitive flames in general, and is described by him as the most sensitive he used, I was naturally interested in his conclusion, surprising and difficult to explain, that the sensitive frequencies found expressed a property of the particular gas and not one due to causes inherent in the apparatus used[2]. Later, Brown suggested that the reaction of the surrounding air to the passage of vortices up the jet might be the controlling factor[3].

In the Physical Society's twenty-fifth Guthrie Lecture[4], Prof. E. N. da C. Andrade seems to dismiss Brown's results somewhat lightly and claims that the origin of such selective responses must be sought in resonances of the particular apparatus and room, although Brown himself appears to have obtained the same frequencies in a different laboratory and with different apparatus[2], and Savić to have found that frequencies measured in Basle agreed with Brown's[5].

A critical comparative examination of the two claims would involve a long investigation; but it occurred to me that Andrade's particular contention could be simply tested by repeating experiments similar to Brown's but under entirely different conditions. Accordingly I made a new glass jet by the old process and investigated its response to pure tones of different frequencies given by a calibrated Muirhead beat-tone oscillator. The curve of flame-height against frequency I obtained is reproduced



Upper curve: London, 1931. W3 brass jet (Brown). Lower curve: Manchester, 1942. No. 1 glass jet (Sutherland).

and for comparison I have plotted Brown's curve for the brass jet W3 operated under a different gas pressure in a room quite different in size and character.

By kind permission of Dr. Ewing my experiments were carried out in a very heavily lagged room in the Department of Education for the Deaf in the University of Manchester, and Dr. T. S. Littler kindly assisted in taking the readings. Though this set of observations and Savić's cannot be held to prove Brown's theory, they do suggest that his results were not fortuitous.

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[1] NATURE, 108, 533 (1921).
[2] Phil. Mag., 13, 161 (1932).
[3] Proc. Phys. Soc., 49, 519 (1937).
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Dealkylation of Phenolic Ethers

SEVERAL methods have been reported in the literature for the dealkylation of ethers; for example, with hydrobromic acid[1], hydriodic acid[2], aluminium chloride[3], aluminium bromide[4], alkyl magnesium iodide[5], aldsol[6], piperidine or moist pyridine[7], aniline hydriodide in aniline[8], and magnesium iodide. Some of these methods appear to be of specific nature only.

I have found that although piperidine and moist pyridine failed to demethylate β-methoxynaphthalene at their boiling points, yet partial demethylation occurred when the reaction was carried out in a sealed tube to 250–300°. Aniline hydriodide in aniline, however, did not effect this demethylation even when heated to 250–270°. The use of quinoline hydriodide or aniline hydriodide in boiling quinoline instead of aniline gave satisfactory results. Although other solvents such as dry pyridine, diphenyl-amine, phthalimide and acetanilide, but not dimethylaniline or α-methylnaphthalene, could replace quinoline, yet the extent of demethylation is much less. The following ethers have been similarly demethylated: 4-methoxy-diphenyl, 6-bromo-2-methoxynaphthalene, 4-nitro-2-methoxynaphthalene, 2- and 4-methoxy-1-benzoylnaphthalene. The mechanism of the reaction is under investigation.

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Experimental Observations on the Relation between Leaf Development and Stelar Morphology in Species of Dryopteris

THE classical accounts of vascular structure in leptosporangiate ferns show clearly that the interruption of the conducting cylinder of the shoot is associated with the 'insertion' of the leaf-traces, that is, the vascular strands of the petiole or leaf-base. Thus, in a solenostelic fern, a cross-section at the level where a leaf-base joins the shoot will show the presence of a leaf-gap; in other words, the vascular

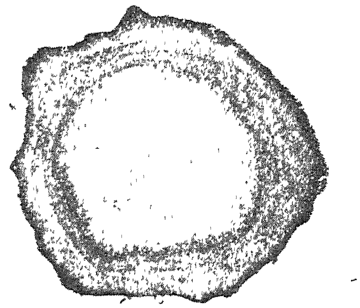

Fig. 1. *Dryopteris aristata*: TRANSVERSE SECTION SHOWING INDUCED SOLENOSTELE IN EXPERIMENTAL REGION OF SHOOT. (× 4.) (PHOTO BY E. ASHBY.)

cylinder which would otherwise be continuous is interrupted by non-vascular tissue, usually parenchyma. In shoots where the leaf-gaps overlap, the vascular system becomes an open meshwork, or dictyostele, each individual strand being described as a meristele. Various tentative physiological explanations have been advanced to account for the development of these leaf-gaps. A considerable volume of literature also deals with the question as to what extent the vascular tissue of the shoot is of truly cauline origin, or alternatively, is a composite structure largely composed of decurrent leaf-traces. So far as I am aware, these problems have not been approached by direct experimental methods. The simple and easily repeatable technique, described below, has resulted in experimental observations of very considerable interest.

The distal ends of erect shoots of *Dryopteris aristata* and *D. filix-mas* were completely defoliated and the scales removed so that the terminal region was left 'naked'. The apical meristematic cone was left intact, but the minute leaf primordia round its base were destroyed by needle-puncturing. For this purpose a Zeiss micromanipulator was used, the material being observed under a binocular microscope. Alternatively, by using a needle on its side and gently moving it over the surface of the shoot away from the base of the apical cone, it was possible to 'smooth

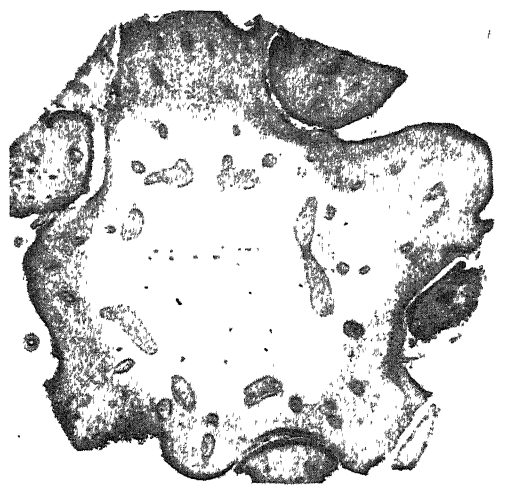

Fig. 2. TYPICAL DICTYOSTELE AND LEAF BASES IN THE UNTREATED REGION BELOW. (× 4.) (PHOTO BY E. ASHBY.)

out' all new leaf primordia without injury to the apical meristem. The apical region was then protected by means of moist cotton-wool and the piece of shoot placed in peat. New leaf primordia were similarly destroyed at weekly or fortnightly intervals. New roots were abundantly formed and some pieces of material were kept alive and in a state of growth for several months, until, in fact, the material was fixed for sectioning.

Transverse serial sections from the apex downwards showed the apical meristem to be still intact and apparently normal, and every stage between complete solenostely and the normal dictyostelic condition of the older region of the shoot was observed (Figs. 1 and 2). Thus where a succession of leaf primordia had been destroyed immediately after their inception, a complete, uninterrupted vascular ring was to be observed; but where a primordium was rather older before it was destroyed, leaf-gaps of small size were present.

A full account of these observations will be given elsewhere.

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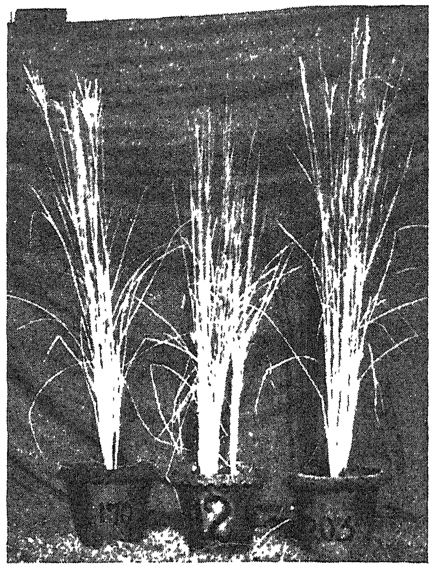
Vernalization of Rice by Short Days

VERNALIZATION by light or the treatment of seedlings to exposures of different light periods in order to accelerate flowering has been effected in temperate cereals. Cailahjan[1] vernalized several varieties of winter wheat and winter rye by continuous light when low temperature had no effect on flowering. Purvis and Gregory[2] have shown vernalization of winter rye both by low temperature and by short days of ten hours. These results indicate the use of light periods for vernalizing cereals which do not respond to Lysenko's method of low-temperature treatment.

Experiments performed by me have shown that vernalization of rice by chilling (3°–6° C.) produces no significant earliness, while treatment of young seedlings by exposures to short days accelerates ear-emergence and increases growth-rate and grain-yield. Seven days old seedlings of a winter variety, 'Bhasamanik', were exposed to eight and ten hours of daylight for varying periods up to six weeks in the seed bed, then the seedlings were transplanted in pots and grown in the field under natural long days. In another experiment short days were given to seedlings in seed bed and continued after transplantation until the ear-emergence was noted in the individual plants. The control plants were exposed all through to normal daylight. Of the seed bed treatments for varying periods an exposure to short days for six weeks duration induces the maximum earliness and grain yield. The results are presented in the accompanying table and the ear-emergence in the treated plants is illustrated in the photograph.

Treatment		Earliness in days (Mean of 15 plants)	Percentage increase of grain yield over the controls (Mean of 15 plants)
	Short days in hours		
Seed bed for 6 weeks	8	10·3	16
	10	12·5	10
Prolonged until ear emergence	8	25	35·3
	10	26·5	18·3



Although greater earliness and yield is obtained by the prolonged treatments, the application of the method in field practices is possible only by the treatment of seedlings in the seed bed. This method of inducing earliness and increased yield is of agricultural importance for the variety of rice grown after transplantation.

A detailed report of the work will be published elsewhere.

I desire to thank Prof. S. P. Agharkar for the facilities to carry out this investigation.

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Jan. 28.

[1] Cailahjan, M. Ch., Review in the *Imp. Bur. Plant Gen., Bull.* 17
[2] Purvis, O. N., and Gregory, F. G., *Ann. Bot.*, N.S. 1 (1937)

Excretions, Ecology and Evolution

PROF. E. J. SALISBURY's important remarks on the probable significance of excretions in biological competition[1] should not need emphasis, although the work of Pickering[2] in 1917 provides yet another reference regarding the excretions of roots. It is to be hoped that the present interest in penicillin may attract the attention of biologists to what appears in reality to be another aspect of that great field of biological study which embraces chemical morphogenesis, endocrinology and, as is now emphasized, ecological and evolutionary succession. In each of these the production of metabolites plays a part in the mediation of subsequent events.

While working under Prof. A. C. Hardy at the time when he was developing his theory of 'animal exclusion'[3], I became interested in such relationships in the sea. Having in mind the striking collection of references collected by Allee[4,5], I was later led to suggest[6] that these 'exclusive' processes might not only be comparable with others in which the excretions of one form were found to be harmful in some instances, but also with those in which the effects of excretions appear to be beneficial at least to some section of the community. The suggestion was made that such processes may, through the continued

biological conditioning of the environment, play a part in the phenomenon of succession in the sea and elsewhere. If this is correct, then it seems likely that Prof. Salisbury's suggestion regarding biological competition may fairly be seen within the wider field of general ecological succession. In particular relation to penicillin, it would be of interest to know whether its effects on the ecological successors of *Penicillium notatum* are harmful or beneficial, since it is possible that at least one of these has acquired tolerance of the excretion, or even 'made use' of it in an adaptive manner.

As a further example of the possible importance of such processes, I should like to refer again[6] to the part which biological conditioning of both types may have played in that major 'succession', evolution itself. It has been pointed out by P. G. 'Espinasse[7] that physiologically active substances are frequently metabolites in which the present-day effects have followed upon their first production. Much of the history of evolution has concerned the development by living things of responses to metabolites, sometimes their own and sometimes produced by others. Those organisms which developed 'satisfactory' responses succeeded, and those which did not, failed. Particularly in so far as evolution may first have proceeded in an aquatic environment, the gradual production of different external metabolites must at each stage have determined to some extent which of new genetic forms should 'succeed' in the field.

Since this letter was written, H. McIlwain's important article has been published[8], and attention should be directed here to his most relevant remarks on biological interactions.

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[2] Pickering, S., *Ann. Bot.*, **31**, 183 (1917).
[3] Hardy, A. C., Discovery Reports, **11**, 273 (1935).
[4] Allee, W. C., "Animal Aggregations" (Univ. Chicago Press, 1931).
[5] Allee, W. C., *Biol. Rev. Camb. Phil. Soc.*, **9**, 1 (1934).
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[7] 'Espinasse, P. G., *Proc. Zool. Soc.*, Lond., A, **109**, 247 (1940).
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p-Aminobenzoic Acid and its Effect on the Sulphanilamide Inhibition of the Growth of Oat Roots

THERE have been many observations on the inhibitory effect of sulphanilamide on the growth of various organisms such as bacteria, yeast, fungi and higher plants. In a recent letter by Brian[1], it was shown that sulphanilamide caused an inhibition of the coleoptile growth of wheat seedlings. The general observation was also made that root-growth was stunted. Brian's results seemed to indicate that the antisulphanilamide activity of *p*-aminobenzoic acid could be absolute, indicating that *p*-aminobenzoic acid was an essential metabolite for wheat seedlings.

In view of these findings, it might be of interest to others in this field to record some observations made in these laboratories on the growth of oats, during the course of some work on *H* 11 extract. It was desirable at one stage to maintain a stock solution free from bacterial growth, and attention naturally turned to sulphanilamide and to the range of concentrations which would be non-toxic to the plants. The seeds (var. Victory, *ON* 160) were germinated and grown for 48 hours in the dark at 25° C. using the technique previously described[2].

TABLE 1. GROWTH OF ROOTS IN TEST SOLUTIONS AS A PERCENTAGE OF THE GROWTH IN WATER.

Test substance	Molar concentration 0·00005	0 0001	0 00025	0 0005	0·001
Sulphanilamide ..	101 1	97 4	85 8	74·8	45·1
p-Aminobenzoic acid ..	96·8	96 0	97·3	93 2	91·0

TABLE 2 GROWTH OF ROOTS IN TEST SOLUTIONS AS A PERCENTAGE OF THE GROWTH IN WATER.

Concentration of sulphanilamide	Concentration of *p*-aminobenzoic acid nil	0·000005 *M*	0·00005 *M*	0·0001 *M*	0 00025 *M*	0·0005 *M*	0·001 *M*
0 001 *M*	46·0	42 1	50·0	50 5	57 0	55·3	53 0

From Table 1 it is seen that the inhibition of growth by sulphanilamide alone first began to be observable at a concentration of approximately 0·0002 *M*, while in a concentration of 0·001 *M* the growth of the roots was approximately 45 per cent of that in tap water. With *p*-aminobenzoic acid alone, the roots showed no stimulatory effects, and indeed some slight degree of inhibition appeared at 0·001 *M*. Using *p*-aminobenzoic acid in relatively non-toxic concentrations, it was not possible to neutralize completely the inhibitory effect of sulphanilamide (Table 2). Some degree of anti-sulphanilamide effect could be obtained, the growth-value increasing from about 45 per cent to a maximum of 57 per cent, a difference representing that between the inhibition caused by a 0·001 *M* and a 0·0008 *M* solution of sulphanilamide. That is to say, a concentration equivalent to about 0·0002 *M* sulphanilamide had been 'neutralized' in its effect by *p*-amino-benzoic acid. With a weaker concentration of sulphanilamide (0·0005 *M* or less) there can be an absolute anti-sulphanilamide effect by the *p*-amino-benzoic acid.

There is thus a 'residual' inhibitory effect not affected by the concomitant application of *p*-amino-benzoic acid when the sulphanilamide is present as a 0·001 *M* solution. These results have been confirmed several times, and we must conclude that the 'residual' inhibition noted above represents an effect of sulphanilamide other than the usually accepted one. Sulphanilamide may indeed be able to 'lock' more than one system of reactions, as, for example, the anti-catalase effect noted by Shinn, Main and Mellon[3], and the inhibition of the oxidation of *p*-aminobenzoic acid catalysed by peroxidase[4].

From the present findings it would appear that *p*-aminobenzoic acid is not, in the fullest sense of the term, an 'essential' metabolite for the growth of oat roots (var. Victory) when these are grown for 48 hours in the dark at 25° C. It does, however, play some part in the physiology of the seedling growth and is, no doubt, present in the seed. It may well be that some other analogue of sulphanilamide could be shown to be such an 'essential' metabolite, a point of interest to workers on the growth of isolated roots of monocotyledons.

I wish to express my thanks to Mr. L. G. Wilkinson for his assistance in this work.

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[2] Forbes Jones, R., and Baker, H. G. *Ann Bot.*, N.S. 7, 379 (1943).
[3] Shinn, R. W., Main, H. J., and Mellon, R. R., *Proc Soc. Exp. Biol. and Med.*, **44**, 591 (1938).
[4] Lipmann, F., *J. Biol. Chem.*, **139**, 977 (1941).

Fat of Sow's Milk

Ellis and Zeller[1] studied the changes in composition of the body-fat of hogs at successive intervals of growth and reared on a ration low in fat. A steady decrease in linoleic acid content occurred from a maximum in suckling pigs up to a weight of 170 lb. They concluded from the low iodine value of sow's milk fat (51·6) that sow's milk was not the source of the relatively high proportion of linoleic acid in the small animals. Callow[2] showed that the iodine value of pig back-fat increased with age until weaning, and regarded this increase as due to assimilation of unsaturated acids from sow's milk. Milk from a slaughtered sow, milk from an unspecified source, and colostrum were shown[3] to have fats with iodine values 80·9, 53·6 and 101·8 respectively. In a subsequent discussion[4] of the relationship between age, rate of growth, and iodine value of pig fat, Callow considered that pre-weaning and post-weaning growth differed in some way not understood.

A sample of sow's milk (130 ml. containing 7·0 per cent fat) obtained by hand-milking a Berkshire sow at appropriate intervals over the period of a week has been examined in this laboratory.

COMPONENT FATTY ACIDS (MOLS PER CENT)

	Steam-volatile	Myristic	Palmitic	Stearic	Hexadecenoic	Oleic	Octadecadienoic	C_{20-22}
Sow's milk fat (Laxa[5])	1·5	2·7	28 0	—	—	67·8	—	—
Sow's milk fat (this investigation)	2·4	1·8	28·3	6·1	8·8	35·0	14·0	3·6
Pig outer back fat (this investigation)	—	1·0	28·8	11·5	5·8	46·0	5·7	1·2

The results of this investigation confirm the presence of not more than small amounts of steam-volatile fatty acids, as found by Laxa[5], whose method did not involve ester-fractionation and gave no indication of the proportion of unsaturated components other than oleic acid. The palmitic acid content is within the range of 28–30 mols per cent typical of animal depots, as found by other workers for buffalo and camel milk fat, but not for sheep, goat, or cow milk fat[6]. The hexadecenoic acid content, and the content of polyethenoid C_{20-22} acids, are both rather greater than found for cow and other animal milk fats[6].

As in the case of cow-milk fats[7], only traces of ether-soluble, petrol-insoluble bromides were obtained by bromination of unsaturated C_{18} fractions. It is unlikely, therefore, that the large amount of polyethenoid C_{18} acids present in these fractions was assimilated by the sow from dietary maize meal and barley meal, the polyethenoid C_{18} acid from which consists largely of linoleic acid. The high unsaturation of the C_{18} fractions from this sample of sow's milk fat may have originated from pasture lipids which are known to contain an octadecadienoic acid isomeric with linoleic acid[8]. Linolenic acid, however, which is a major component acid of pasture lipids, was not detected in this sample of sow's milk fat. It is interesting to note that the milk of pasture-fed cows contains only small proportions (2–4 per cent) of octadecadienoic acid, and the addition of oils containing linoleic and linolenic acids to cow's diets produces no significant increase in the amount of polyethenoid acids in milk fats[9,10].

As compared with butterfat, therefore, it seems probable that sow's milk fat contains more octadecadienoic acid, and the assimilation of this acid from the diet of the suckling pigs provides a reasonable explanation of the increase in iodine value of pig depot fat from birth until weaning.

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[1] Ellis and Zeller, *J. Biol. Chem.*, **89**, 185 (1930)
[2] Callow, Report Food Invest. Board, 1937.
[3] Callow, Report Food Invest Board, 1937.
[4] Callow, Report Food Invest. Board, 1938.
[5] Laxa, *Ann. Falsif.*, **24**, 87 (1931).
[6] Hilditch, "The Chemical Composition of Natural Fats" (Chapman and Hall, London, 1941).
[7] Hilditch and Longenecker, *J. Biol. Chem.*, **122**, 497 (1938).
[8] Smith and Chibnall, *Biochem. J.*, **26**, 218 (1932).
[9] Hilditch and Sleightholme, *Biochem. J.*, **24**, 1098 (1930)
[10] Hilditch and Thompson, *Biochem. J.*, **30**, 677 (1936).

A Standardized Antibacterial Pyrogen-free Metabolite Preparation containing Living *Penicillium notatum*

A SUSPENSION of *Penicillium notatum* (Fleming) hyphæ in a fluid medium, obtained from below the mycelium of the mould at the stage of its highest rate of penicillin production and freed from pyrogens and other impurities, contains also antibacterial metabolites which are normally present in penicillium culture fluid. From its therapeutic results on animals, it appears that the effects of this suspension, in addition to the penicillin effect, are due to the presence or production of other potent bacteriostatic compounds—which are destroyed or left behind in the manufacture of penicillin—and to the continuation of the formation of penicillin *in vivo*.

From observations on animals it has been found that the suspension is active in the presence of serum, pus, blood and tissue autolysates, and is not inactivated by sulphonamides or sulphonamide inhibitors. It has, so far, not proved pyrogenic in animals or man, and has shown no signs of local or general toxicity, allergic sensitization or discomfort except for a slight local burning sensation after injecting, lasting only a few minutes. It appears to differ, therefore, from crude penicillin extracts containing no living cultures, which can cause toxic and sometimes painful reactions due to impurities present. Whereas a single dose of several thousand Oxford units of penicillin is rapidly eliminated in the urine, the therapeutic effect of one injection of the suspension (1 c.c. per 20 lb. bodyweight), on the other hand, appears to last for 36–48 hours. Where the response to one intramuscular injection did not completely clear an infection, a second injection in most cases did so. The characteristic fall of fever in pyrogenic infections within three to four hours of administering a dose of the suspension, and the immediate relief of pain observed in a number of infections in the experimental animals, are clear and typical indications of the promptness of the therapeutic response to the preparation.

Twenty-one cases of animal infections were treated with the suspension. Of these, fourteen were absolutely positive—three of them astonishingly rapid in response—three were doubtful and inconclusive, and four were negative. No ill-effects were observed in any of these cases. In the four negative cases

no harmful effects could be attributed to the injection, even when given intravenously. The infections which responded to treatment were gastro-intestinal (*B. coli*), staphylococcal, streptococcal and pneumococcal types, while virus infections do not seem to respond.

This preparation from *Penicillium notatum* seemed exceptionally potent in the treatment of open wounds with pyrogenic mixed infections, and also when used intramuscularly for the treatment of pyrogenic and gastro-intestinal infections. The evidence of its value in old chronic infections is inconclusive. It appears that intramuscular injections are as efficient as intravenous injections. The preparation is standardized for the hyphæ content by the turbidity against barium sulphate (nephelometer) or by an indirect all-count in comparison with a drop of blood. The antibacterial activity can be assayed *in vitro* by the Florey-cup or by the Fleming dilution method, or *in vivo* by animal protection tests.

In human beings the preparation is well tolerated without toxic reactions or sensitization becoming apparent. The therapeutic response is prompt, usually within 3–4 hours after the first injection. Controlled clinical results have already been obtained in sulphonamide-resistant pneumonia, acute staphylococcal, streptococcal and other infections, and it is hoped they will be published shortly.

We wish to express our thanks to Mr. E. von Lustig-Lendva, who was responsible for carrying out the preliminary animal tests.

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Origin of Indo-European Languages

COMMENTING on Prof. Alexander Jóhannesson's recent article, Mr. Allan S. C. Ross[1] states: "In all languages known to us . . . for the great majority of words, the connexion between sound and sense is random". But he does not say whether this also applies to the connexion between mouth gesture and sense, which was what Prof. Jóhannesson has been particularly investigating.

Yet it can scarcely be disputed that the sounds of speech are, in fact, a secondary effect of the gestures of articulation which produce the various sounds of speech. If this is so, then it would appear that the "excellent minute" of the Société de Linguistique which Mr. Ross quotes is out of date, and that the "origin of language" is now ripe for discussion, on the basis of mouth gesture.

Having made a fairly wide examination of the connexion between mouth gesture and sense in various languages, and of the meaning which hand gestures (in sign language) and mouth gestures (in speech) actually convey, I can offer evidence of the survival of significant mouth gestures. In English, for example, about 75 per cent of all the short words are 'gestural'; that is, the mouth gestures which produce the words are themselves a pantomimic representation of the primitive meaning of the words. Thus, of the 79 short words beginning with *GR*- (a gripping, surrounding, enclosing or clawing gesture), 73 per cent are gestural; of the 25 short words beginning with *SCR*-, *SKR*-, 88 per cent are gestural, and of the 39 short words beginning with *STR*-, 90 per cent are gestural, while 100 per cent of short words ending in -*OOP* or -*OUP* are gestural.

In Chinese the same conditions obtain; and of 36 words pronounced *KU* or its variants (*K'U*, χU, χUA, *KÜ* and *KUAI*) 34 (94 per cent) are found to be gestural. Similarly, of 19 short Greek words beginning with γλ- (*GL*), 15 (78·9 per cent) are gestural. Such connexions can certainly not be described as random.

Mr. Ross also states that "linguistic changes which must have operated in the long period intervening" (that is, between the origination of a language and its development as a written language) "would certainly have quickly reduced a non-random sound-sense relation to a random one". On this count also the gestural evidence is against him.

Investigation of the mouth gestures involved in "linguistic changes" and "ablaut" shows that, as a rule, the original significant gestures do not change; what changes is the manner in which the individual gestures are made, the changes being mostly in the direction of unconsciously making the gesture easier to perform. Thus, a complete closure of the tongue against the throat, palate or back of the teeth may become a partial closure *in the same position*. A complete lip closure may become a partial closure, a voiced consonant may become unvoiced, or the level of the tongue or the opening of the lips may be varied, for convenience in combining a given vowel posture with a particular consonant gesture. In other words, the 'fashions' in performing the mouth gestures vary—like other human fashions—but the gestures persist. Philologists should study mouth gestures. If they fail to do so, they will be in no position to criticize Prof. Jóhannesson's theories.

Human speech is, admittedly, a highly important branch of human behaviour; if its votaries will study the system of gestures to which audible speech is due, philology will indeed become a science, and—linked with the study of sign language—will take its place as an essential part of anthropology.

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[1] NATURE, 153, 257 (1944).

Pectoral Gland in Apes and Monkeys

PROF. OSMAN HILL's interesting account of the gland on the chest of a male drill[1] reminds me that nearly twenty years ago[2] I described and figured a somewhat similarly situated gland in two adult male gibbons from Borneo. In these apes, the glandular area superficially is an elongated triangular patch of thickened skin sparsely covered with short hairs, and in one of the specimens with blackish secretion. It is broad above and narrowed below, and extends from the region of the inner ends of the collar-bones downwards and terminates in a point a little below the mammæ. Although I had one of these gibbons under observation in the Zoological Gardens at Regent's Park, London, neither I nor the keeper in charge ever saw the animal evince the least sign of being aware of the existence of the gland; but Prof. Hill's amusing description of the conduct of the drill in connexion with its pectoral gland shows that there is still a great deal of interesting information about the behaviour of wild animals to be learnt by observing them in captivity.

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[1] NATURE, 152, 199 (1944).
[2] *Proc. Zool. Soc.*, 1492 (1925).

ELECTRICITY SUPPLY IN GREAT BRITAIN

TWO documents have recently been published on this subject which are likely to have important repercussions in the electricity supply industry of Great Britain. The first of these is a memorandum issued by the Incorporated Association of Electric Power Companies*, and the second is the report made to the Council of the Institution of Electrical Engineers by its Post-War Planning Committee, on electricity supply, distribution and installation†.

Administrative Aspects

The memorandum issued by the Incorporated Association of Electric Power Companies refers to the progress of, and developments and legislation in, the supply industry, to the Electricity Commission, and to the work and recommendations of the McGowan, Cooper, and Scott Committees. Proposals are then made for the consideration of the Minister of Fuel and Power in respect of (1) electricity distribution, and (2) the Electricity Commission. Their essential features are abstracted in the following.

Electricity Distribution. Improvement should be generally on the lines of the McGowan Report, subject to the amendments cited later. Legislation should be passed at or before the end of the War to suspend the exercise of the rights of purchase by local authorities and others of any electricity undertaking, but such suspension should not prevent the completion of negotiations for the voluntary acquisition or amalgamation of such undertakings. The Electricity Commissioners should delimit suitable electricity districts and appoint a scheme committee for each district to prepare and submit to the Commissioners a draft scheme for the improvement of distribution in the district in accordance with the terms of the McGowan Report. The scheme committee should consist of representatives of the authorized undertakers in each electricity district. Should the scheme committee fail to prepare or forward a draft scheme for any electricity district, the onus would fall on the Electricity Commissioners.

The Electricity Commissioners should be empowered to make any scheme, but should not make one other than an agreed scheme without holding a local inquiry. The Minister of Fuel and Power should be empowered to confirm any scheme made by the Electricity Commissioners, and any scheme confirmed should be subject to the approval of Parliament. The proposed legislation should prescribe the basis of the purchase price to be paid for the acquisition of any undertaking. Tariff forms throughout Great Britain should be standardized so far as possible. Complete uniformity of charges for the whole country is not economically possible, but may be feasible in an electricity district, and has already been attained in a number of large areas. Retained undertakers should be under an obligation to standardize voltages and systems, as may be determined by the Electricity Commissioners. Legislation should provide in the case of retained undertakers for the application of an effective sliding scale relating prices to costs and charges, including a reasonable return on capital employed. All retained undertakers should be obliged to submit periodically to the Electricity Commissioners proposals for the development of the supply of electricity for general domestic purposes, including lighting in any part of their area where there is a demand for such a supply and a prospect of such supply affording reasonable return to the undertakers.

The Electricity Commissioners should appoint a local committee in each area to consult with the retained undertakers on matters affecting development of supplies and prices. The local committee should be representative of local authorities and consumers and should have power to initiate applications to the Electricity Commissioners regarding such matters.

The present system of valuation and rating as affecting the industry has been adversely commented upon by various departmental committees, and it is considered that the whole system should be reviewed. The proposed legislation should include various provisions recommended by the McGowan Committee on matters such as the procedure for obtaining wayleaves, fixing wayleave rentals and compensation, public supplies of electricity by unauthorized undertakers, and the consolidation of the numerous Electricity Acts into one up-to-date enactment. It is considered that the conclusions of the McGowan Committee and the Cooper Committee and also the views already expressed regarding public corporations and regional boards apply equally to 'public ownership'. If, however, Parliament decides that retained company undertakings should be liable to purchase by some form of public authority, it is considered that the prescribed period should be not less than fifty years and that the option to purchase should be exercisable at the same date for all undertakings. If, at the expiry of fifty years, purchase were not deemed expedient, there should be recurring options at reasonably lengthy intervals.

The Electricity Commission. It is the view of the Incorporated Association of Electric Power Companies that the establishment of the Electricity Commission was and is still necessary to the industry. The Minister should have the widest choice in appointing suitable men to the Commission, and the Commissioners, in turn, should be enabled to appoint an experienced and well-paid staff. It is recommended that five Commissioners be appointed at the earliest possible date and that all the Commissioners, including the chairman, should be men of long and wide experience in the industry. The staff of the Commission should be strengthened and reorganized at the earliest possible date and there should be removed any obligation that its members should be governed by Civil Service conditions and rates of pay. The Electricity Commissioners should have the assistance of an advisory committee to be appointed by the Minister of Fuel and Power after consultation with the electricity supply associations, in regard to the delimitation of electricity districts and other proposals.

Technical Aspects

The second report, sponsored by the Institution of Electrical Engineers, is confined to technical matters of immediate urgency in connexion with electricity supply, distribution and installation in Great Britain, and it excludes problems of generation and main

* Memorandum with regard to the Electricity Supply Industry in Great Britain. Pp. 30. (Incorporated Association of Electric Power Companies, 58 Abbey House, Victoria Street, London, S.W.1. 1943.)

† Electricity Supply, Distribution and Installation: a Report to the Council of the Institution of Electrical Engineers from the Post-war Planning Committee. Pp. ii+26. (Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. 1944.)

transmission, for which technical policy is already co-ordinated by the Central Electricity Board.

For low-voltage distribution systems, a four-wire, three-phase, 400/230 volt system is the national standard. Its extension throughout Great Britain is recommended as an urgent post-war national industrial plan. Data are given on which a scheme to secure standardization may be based. Complete standardization of all low-voltage distribution systems presents no technical difficulties and could be completed within five years. As the benefit of such voltage standardization mainly accrues to the entire community, it may be the subject of financial discussions with Government, and a detailed estimate has been made of its cost, which amounts to some £17·5 millions, based on 1939 conditions and price-levels.

A brief historical review of the development of urban electricity in Great Britain leads up to the position in 1939, when of 10·7 million urban dwellings, 7·9 million were supplied with electricity; among 2·25 million rural dwellings, 1·1 million received a supply, together with at least 35,000 farms. For the completion of rural electrification financial aid will be required for connecting consumers remote from transmission lines, preferably granted for schemes embracing districts as a whole. Wayleave procedure should be simplified and the use of under-eave construction facilitated. Agreement by undertakings on a standard length of underground service cable, laid free, is recommended. A free overhead service line to a total cost not exceeding that of installing the agreed length of underground service cable is suggested. Simplified and less expensive constructions for high-voltage spur lines are proposed, and agreed standards are recommended. Expenditure on such overhead lines must usually be justified by adequate revenue, unless the consumer contributes to first cost or a subsidy is available. Legislation is recommended to bring English law into conformity with Scottish law, which allows a tenant to secure compensation from the landlord for the cost of any wiring installation put in by the tenant. Low-interest loans for wiring, etc., or hire-purchase terms for a ten-year period are advocated.

A report issued in 1930 of a committee set up by the Electricity Commissioners gave a comprehensive picture of the situation at that time and remains largely applicable. The time is appropriate for securing uniformity of tariff forms, and recommendations are made to this end. The merits of the two-part tariff are discussed and recommendations for its wide extension are made. Consumers are classified into the groups domestic, farm, industrial and commercial, and recommendations are made for the equitable assessment of the fixed or primary charge component of the tariffs appropriate to each group. The Electricity Commissioners, it is suggested, should be authorized to permit any undertaking to offer a two-part tariff only, with no alternative flat-rate, subject to certain safeguards to the consumer. Descriptions are given, and the advantages are discussed, of two-part variable-block tariffs, for the above groups, and examples of the working of each are quoted.

Basic changes in the Regulations for the Electrical Equipment of Buildings of the Institution are proposed, leading to their division into Basic Safety Regulations (accompanied by a Code of Practical Interpretation) and supported by Codes of Good Practice to be prepared by the independent Codes of Practice Committee, set up under the ægis of the Ministry of Works. It is recommended that this very important matter be given early consideration.

No full assessment of the matter of legislative control of the electrical equipment of buildings has been attempted, but an appraisement of the technical aspects of the available evidence does not support a need for the compulsory registration of contractors and operatives or for the exactment at present of compulsory wiring regulations. If necessary, the proposed Basic Safety Regulations could later be given the force of law. Extension of inspection of installations by supply undertakings, more general observance of the wiring regulations, wider use of the voluntary system of registration of installation contractors, insistence on the use of non-kinkable cords for portable apparatus, and the manufacture of accessories and apparatus to extended and specific British standard specifications are recommended.

OPHTHALMOLOGY IN GREAT BRITAIN

THE work of the modern ophthalmologist and the tasks he has to face in the future are the subjects of two articles in the *British Medical Bulletin* (1, No. 9; 19 3). These articles inaugurate a series of outlines of special aspects of British medicine which that journal will publish at irregular intervals in the future.

Discussing the future work of the ophthalmologist, Prof. Arnold Sorsby gives most of his space to blindness, adopting the criterion that blindness means being "so blind as to be unable to perform any work for which eyesight is essential". He finds that there are at least 100,000 blind people among the population of about 40 million in England and Wales, which is a rate of 2·5 per thousand. It is likely that even now all the blind are not registered by a medical examiner for the benefits obtainable under the Blind Persons Act of 1920.

In 1910 it was estimated from the census returns of various countries that there were about 3 million totally blind people in the world, but, on the basis of the rate for England and Wales, the world figure would be 5 million. Blindness is, however, much more frequent in India, China and the Middle East than it is in Britain. China alone probably has 4–5 million blind people and India may have almost as many. Prof. Sorsby suggests that there are probably 15 million blind people in the world, and that many millions more have grossly defective sight. Apart from the immediate exciting causes of blindness, the great determining causes are ignorance and poor social and medical services.

The prevention of blindness—surely one of the major tasks of the future—is considered under five headings. Among the infective processes causing blindness, ophthalmia neonatorum of the newborn is no longer significant, nor is smallpox now a serious cause of eye disease. Trachoma and the acute ophthalmias of the tropics are not yet controlled. Trachoma probably affects about 15 per cent of the world's population, and its cause is not understood. Possibly a remedy may be found among the sulphonamides. The control of tuberculosis has helped greatly to diminish phlyctenular ophthalmia, the prevalent ophthalmia of childhood, due to tuberculous sensitization. Advances in public health and hygiene have

also helped the tasks of the ophthalmologist. But the lack of any specific treatment for tuberculosis makes it difficult to control tuberculous allergy of the eye. Until we find an antisyphilitic agent which will reach and act on the brain and the eye, treatment of ocular syphilis will be unsatisfactory.

Among genetic affections of the eye, malformations and hereditary anomalies cause the blindness of some 50 per cent of blind children. Geneticists should find interesting material in the study of *glioma retinæ*, a disease which behaves as an irregular dominant in some families. We need to know why it does not behave as a dominant in those transmitters of it who do not suffer from it.

Among nutritional and metabolic disorders, xerophthalmia is a major problem in China and India. Work is needed on the correlation of nutrition with ocular health and we need better methods of studying the physiology of the eye, so that problems which, like diabetic retinitis, are related to faulty metabolism of the body as a whole, may be tackled on a proper basis. Such methods would also help the study of cataract and glaucoma, which are, according to English and North American statistics, responsible for 25–40 per cent of blindness.

Finally, in children and young adults, injuries are important. War is the greatest single cause of blindness, and it poses its own special problems—the extraction, for example, of non-magnetic fragments from the interior of the eye, such fragments being, in the present War, largely non-magnetic, while those encountered during the War of 1914–18 were not.

In a section on ocular hygiene Prof. Sorsby echoes the opinions of the leaders of modern medical thought when he reminds us that nowadays we tend to take 'optical aids' as a matter of course, and to forget the environmental conditions of those who have to use them. It is good to learn that England may have a national eye service for all, an important part of which will be the research facilities which are essential to its progress. The *British Medical Bulletin* points out that the Oxford University Ophthalmic Research Endowment Committee is appealing for funds for the endowment of the newly established Department of Ophthalmology at Oxford after the War. Reference was made to this project in NATURE of September 18, 1943, p. 323.

In another special article in this issue of the *British Medical Bulletin*, R. R. James gives an outline of the history of English ophthalmology since its beginnings in the days of the Roman occupation. After the Romans left, the Anglo-Saxons and Normans did little to improve ophthalmic practice, but in the thirteenth century Roger Bacon and John of Peckham initiated the use by old people of lenses for reading, and the science of optics began. Early in the seventeenth century the itinerant oculist Richard Banister of Stamford directed attention to hardness of the eyeball as a cardinal sign of glaucoma, a discovery which was forgotten for 150 years. Banister seems to have been an honest and remarkable member of an itinerant fraternity whose practices should make entertaining reading. Mr. James describes the eighteenth century as the age of ophthalmic quackery, but during it modern ophthalmology was founded by Cheselden, Sharp, Warner and others. In 1805 the Moorfields Eye Hospital, now the Royal London Ophthalmic Hospital, was founded. Exeter established an eye hospital in 1808 and Manchester in 1814. The subsequent landmarks in ophthalmic history given by Mr. James indicate that, when Sir William Bowman, who gave his name to Bowman's membrane, abandoned general surgery to become the first ophthalmic specialist, he began that specialist service which to-day must face so many urgent tasks.

G. LAPAGE.

THIOUREA AS PROTECTIVE AGENT FOR VITAMIN C

FOOD products rich in ascorbic acid, such as those made from citrus and other fruits, should be processed under conditions in which the vitamin is not destroyed. Ascorbic acid loses its antiscorbutic action when the cyclic structure of the molecule is changed by the opening up of the lactone ring. In alkaline solution this takes place spontaneously with formation of diketogulonic acid, which afterwards breaks down to threonic and oxalic acids from which the vitamin cannot be recovered by simple reduction. This does not readily happen in acid solution, and the vitamin may be oxidized to the dehydro form and quantitatively recovered by the use of the appropriate reducing agents.

Oxidation of the vitamin can occur in the absence of molecular oxygen provided the solution is activated by (1) ultra-violet light, (2) copper, (3) pyridine nucleotides, or (4) enzymes of the type of ascorbic acid oxidase. The possible significance of copper contamination has been recognized in an order by the Ministry of Food by which manufacturers of fruit concentrates containing vitamin C are required to satisfy the Ministry that their process plants do not come in contact with fruit juices.

It may be sufficient for industrial purposes to ensure that the boiling pans are not lined with copper, the effect of copper parts of the cold sections of the plant being disregarded. Contamination by ionic copper is likely to be much more troublesome, since the metal may be introduced in the water and carried by the fruit, which is often copper-sprayed. Substances capable of protecting the vitamin from destruction following oxidation are (1) substances which stabilize the vitamin in its oxidized (dehydro) or its reduced forms, since either are of equal value in nutrition; (2) reducing agents capable of maintaining the vitamin in the stable or reduced form; (3) buffers which keep the solvent from becoming alkaline; and (4) substances which act as anti-catalysts either by depressing the ionization of copper present in the solution or by combining with ascorbic oxidases.

Reduced ascorbic acid is stable in tissue fluids and in natural and processed food materials containing appreciable quantities of copper. This stability is due to the presence of substances such as glutathione which form copper compounds of a low degree of ionization. E. Kawereau and W. R. Fearon (*Sci. Proc. Roy. Dublin Soc.*, 23, 171; 1944) have recently investigated a large number of substances which might protect ascorbic acid from oxidation in the presence of copper. Of all the simple solutes tested, thiourea was outstanding in its protective power. It appears to be of very low toxicity and is excreted unchanged by the kidney after administration to human subjects. It displays none of the pharmacological effects possessed by some of the substituted thioureas. The authors, however, consider that more work is required on the effects of long-continued

administration and the possible formation of decomposition products during prolonged boiling with fruit extracts, before the general use of thiourea as a protector of vitamin C in large-scale industrial work can be advocated; but it appears most promising of all compounds tested. Boiled vegetable extracts display a similar power of protection, which in some preparations is so complete as to suggest the presence of specific stabilizers of possibly the thiol class. Cabbage, for example, contained an unidentified volatile thiol compound and potato juice yielded an active distillate on boiling.

EFFECT OF DRINKING SMALL QUANTITIES OF SEA WATER

DR. W. S. S. LADELL, of the National Hospital, Queen Square, London, has studied the effects of drinking small quantities of sea water (*The Lancet*, Oct. 9, 1943, p. 441). The work was done for the Medical Research Council's Committee on the care of shipwrecked personnel (M.R.C. War Memo. No. 8, which does *not* recommend the drinking of sea water). A full report of Dr. Ladell's work will be issued later.

A man requires 800–1,000 c.c. of water a day. With less than this he contracts a water debt to his tissues. With a water debt he continues to produce only 350–450 c.c. of urine a day (instead of the normal 1 litre or so), whether the water debt is large or small. During this low urinary output, the urea concentration in the urine rose to as much as 6 per cent; but the total urea output was inadequate and there was nitrogen retention with a rise of blood urea. At the same time, the salt losses in the urine were high on the first day, but they fell in a day or two to a low level. The diet of each subject of all the experiments was 'shipwreck diet' of 1 oz. daily of biscuits, sweetened condensed milk, butter fat or margarine, and chocolate. This provided not more than 1 gm. of sodium chloride daily, but more than this was excreted, so that, when no sea water or saline was drunk, there was always a slight negative salt balance. There was a definite psychological value in having an extra volume of fluid to drink (water supplemented with 3·5 per cent sodium chloride solution or with sea water), even though it tasted salty.

The results, briefly stated, were that the effects of drinking up to 400 c.c. of sea water a day, when the subjects were either totally or partially deprived of fresh water, were, on the low-calorie and low-salt diet provided, an increase in the output of urine, with an improved total urea clearance; a slight gain to the body of water, because the extra water lost in the urine is less than the extra water taken in as sea water; and an initial retention of chloride equal to the chloride lost before the subjects began to drink sea water and, after this, a full excretion of all the chloride ingested. This restoration of the total sodium chloride content of the body may have been a manifestation of the body's tendency, indicated by the work of others whose work is quoted, to conserve its extracellular, at the expense of its intracellular, fluid.

Readers interested in the medical problems presented by the survivors of shipwrecks will find useful Surgeon-Captain Critchley's book, "Shipwreck Survivors, a Medical Study" (J. and A. Churchill, London, 1943, 7*s*. 6*d*. net).

FORTHCOMING EVENTS

(*Meetings marked with an asterisk * are open to the public*)

Saturday, March 25

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—"The Assessment of Lens Performance" (Mr. A. Cox: "General Theory of Lens Performance"; Mr. H. W. Martin: "Lens Types and their Characteristics").

BIOCHEMICAL SOCIETY (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W 1), at 2.30 p.m.—Annual General Meeting.

Monday, March 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C 2), at 1.45 p.m.—Dr. Franklin Kidd: "Dehydration of Foodstuffs" (Cantor Lectures, 2).

Tuesday, March 28

INSTITUTE OF FUEL (joint meeting with the BRITISH COAL UTILIZATION RESEARCH ASSOCIATION) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 10.30 a.m —Symposium on "Underfeed Stokers as applied to Furnaces".

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. F. A. Secrett: "Mechanisation in Market Gardening".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. Arnold Sorsby: "Blindness in Childhood; Past Achievements and Present Problems".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, G.B.E., Pres.R.S.: "Chemical Factors in Nervous Effects", 2: "The Appearances of Two of these Substances in Nervous Activity; Adrenergic and Cholinergic Nerves".*

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m. —Discussion on the Supply and Distribution Sections of the Report on "Electricity Supply, Distribution and Installation" prepared by Sub-Committee No. 3 of the Post-War Planning Committee (to be opened by Mr. P. E. Rycroft).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Annual General Meeting. Mr. F. W. Coppin: "Production of Photographic Templates".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 6.30 p.m.—Mr. J. H. G. Monypenny: "The Sigma Phase and its Significance".

Wednesday, March 29

INSTITUTION OF NAVAL ARCHITECTS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 12 noon—Annual General Meeting.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. E. R. Hamilton: "Education To-day and To-morrow", 7: "The Training of the Teacher".

Thursday, March 30

TOWN AND COUNTRY PLANNING ASSOCIATION (at 1 Grosvenor Place, London, S.W.1), at 1.15 p.m.—Rt. Hon. Earl De La Warr: "National Planning Policy in relation to Agriculture".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Mrs. Kathleen Lonsdale: "Diamonds—Natural and Artificial".*

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. Arnold Sorsby: "The Sulphonamides in Ophthalmology; their Use and Limitations".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. A. Harle and Mr. R. W. Wild: "Restriking-Voltage as a Factor in the Performance, Rating and Selection of Circuit-Breakers"; Mr. H. E. Cox and Mr. T. W. Wilcox: "The Influence of Resistance Switching on the Design of High-Voltage Air-Blast Circuit-Breakers".

INSTITUTION OF ELECTRICAL ENGINEERS (CAMBRIDGE AND DISTRICT WIRELESS GROUP) (at the University Engineering Department, Trumpington Street, Cambridge), at 8.15 p.m.—Mr. R. H. Angus: "Transients on Transmission Lines".

Friday, March 31

OIL AND COLOUR CHEMISTS' ASSOCIATION (MANCHESTER SECTION) (at the Engineer's Club, Albert Square, Manchester), at 2 p.m.—Mr. W. A. Silvester: "Patents at Home and Abroad".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. Stanley Unwin: "Publishing in War and Peace".

Saturday, April 1

BRITISH ASSOCIATION OF CHEMISTS (LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. R. G. W. Norrish, F.R.S.: "Chemistry and the Community".

Thursday, March 30—Tuesday, April 4

BRITISH PSYCHOLOGICAL SOCIETY (at the Training Centre, Jordanhill, Glasgow, W.3).—Annual General Meeting.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned

LABORATORY ASSISTANT (temporary), experienced in pathological and bacteriological work, in the County Public Health Department—The County Medical Officer, County Hall, Wakefield (March 28).

LECTURER IN MATHEMATICS AND CHEMISTRY in the School of Building—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (March 29)

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.902A), and a JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No E.903A), by the Sierra Leone Government—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No) (March 31).

TECHNICAL ASSISTANT, Grade I (location. London, with travelling) (applicants must be qualified electrical engineers with experience of electrically driven excavating machinery)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.776A) (March 31).

PRINCIPAL OF TOXTETH TECHNICAL INSTITUTE, Liverpool—The Director of Education, Education Offices, 14 Sir Thomas Street, Liverpool 1 (April 1).

TWO FULL-TIME LECTURERS FOR (1) MECHANICAL ENGINEERING and (2) ELECTRICAL ENGINEERING, in the East Ham Technical College—The Secretary for Education, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E.6 (April 1).

WELDING OFFICERS by a Government Department to give technical assistance in designing for welding and the welding of armour plate and fabricated steel structures, etc.—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No C.2060A) (April 3).

EXECUTIVE ENGINEERS by the Gold Coast Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.908A) (April 3).

PRODUCTION ENGINEER with mechanical and electrical training and experience, to assist Works Director of large company of manufacturing electrical engineers having several factories in England—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.1973XA) (April 3).

ASSISTANT TO THE DIRECTOR—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge (April 5).

METALLURGIST with a sound physical metallurgical or physical-chemical training, for research work connected with Metallic Arc Welding—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2182XA) (April 6).

READERSHIP IN MINERALOGY—The Registrar, University Registry, Oxford (April 8).

WAYNFLETE PROFESSORSHIP OF METAPHYSICAL PHILOSOPHY—The Registrar, University Registry, Oxford (April 13).

RESEARCH WORKER (who should be a PHYSICIST) in the Coal Treatment Laboratory of the Mining Department—The Secretary, The University, Edmund Street, Birmingham 3 (April 15).

LECTURER (preferably a woman) IN BIOLOGY—The Warden, Goldsmiths' College, at University College, Nottingham (April 15).

ASSISTANT HYDROGRAPHIC SURVEYORS by the Kenya Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.904A) (April 15).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

CHAIR OF PHILOSOPHY at the University of the Witwatersrand, Johannesburg—Dr. William Cullen, 4 Broad Street Place, London, E.C.2 (May 1).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

BOTANIST (male) in the Branch of Plant Pathology and Botany of the Department of Agriculture, Southern Rhodesia—The Official Secretary, Rhodesia House, 429 Strand, London, W.C.2.

SENIOR LECTURER IN THE PHYSIOLOGY DEPARTMENT—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9.

GRADUATE TEACHER FOR MATHEMATICS with some GENERAL SCIENCE (ordinary National Certificate standard)—The Principal, Technical Institute, Beckenham.

GRADUATE LECTURER IN MECHANICAL ENGINEERING SUBJECTS to Engineering Degree and Higher National Certificate standards—The Principal, Kingston Technical College, Kingston, Surrey.

ASSISTANT MASTER to teach MATHEMATICS, TECHNICAL DRAWING and SCIENCE in the Junior Technical School of the Oldham Municipal Technical College—The Director of Education, Education Offices, Union Street West, Oldham.

TEACHERS (temporary full-time) OF ENGLISH SUBJECTS AND MATHEMATICS; ENGLISH, MATHEMATICS and ELEMENTARY SCIENCE; RADIO and PHYSICS—The Secretary, Northern Polytechnic, Holloway Road, London, N.7.

ASSISTANT (male or female) IN THE CHEMICAL DIVISION of the County Laboratory—The County Analyst, County Buildings, Worcester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 39: The Elasticity of a Network of Long-chain Molecules, 2. By L. R. G. Treloar. Pp. 6. Publication No. 40: The Physical Chemistry of Rubber Solutions. By G. Gee. Pp. 30. Publication No. 41: Rubber, Polyisoprenes and Allied Compounds, Part 5: The Chemical Linking of Rubber and of other Olefins with Phenol-Formaldehyde Resins. By J. I. Cunneen, E. Harold Farmer and H. P. Koch. Pp. 6. Publication No. 42: The Statistical Length of Paraffin Molecules. By L. R. G. Treloar. Pp. 18. Publication No. 43: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, Part 7: Rearrangement of Double Bonds during Autoxidation. By E. H. Farmer, H. P. Koch and D. A. Sutton. Pp. 8. (London: British Rubber Producers' Research Association.) [212

Royal Astronomical Society. List of Fellows and Associates, 1943 December. Pp. 40. (London Royal Astronomical Society.) [222

Sex Teaching in Schools Statement by the Executive of the National Union of Teachers. Pp 12. (London. National Union of Teachers.) [242

Regulations for the Electrical Equipment of Buildings. Eleventh edition, revised. Pp. vi+174. (London: Institution of Electrical Engineers.) Paper, 1s. net, cloth, 1s. 6d. net. [252

Association of University Teachers. Report on University Developments. Pp. 16. (Bristol J. W. Arrowsmith, Ltd.) 1s. [282

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 807, Vol. 239: Invariant Theory, Tensors and Group Characters By D. E Littlewood. Pp. 305–365. (London: Cambridge University Press.) 9s. 6d. [292

University of London: University College. Annual Report, February 1943—February 1944. Pp. 52. (London: Taylor and Francis, Ltd.) [63

Post-War Plenty for All: How to Make It Possible. By Wilfrid Hill Pp. 8. (London: Joint Council for Monetary and Economic Research.) [63

Industrial Planning and Research—Catchwords or Realities? By Dr. F. J. North. (Inaugural Address for Session 1944, read before the South Wales Institute of Engineers, at Cardiff, January 20th, 1944.) Pp. 38. (Cardiff: South Wales Institute of Engineers.) [73

Freshwater Biological Association of the British Empire. Scientific Publication No. 8. Keys to the British Species of Aquatic Megaloptera and Neuroptera. By D. E. Kimmins. Pp. 20. (Ambleside: Freshwater Biological Association of the British Empire.) 1s. 6d. [93

Management in Action. Report of the October 1943 Conference of the Institute of Industrial Administration. Pp. 136. (London: Institute of Industrial Administration) 2s. 6d. [93

National Smoke Abatement Society. Fourteenth Annual Report for the Year ended 31st December 1943. Pp. 16. (London: National Smoke Abatement Society) 2d. [103

Other Countries

Tanganyika Territory: Department of Lands and Mines, Geological Division. Bulletin No. 16: The Mineral Resources of Tanganyika Territory. By Sir E. O. Teale and F. Oates. Pp. viii+192. (Dar es Salaam: Government Printer.) 15s. [212

Transactions of the San Diego Society of Natural History. Vol. 10, No. 1: On the Generic Relationships of Certain Californian Xerophile Snails. By S. Stillman Berry. Pp. 24 (plates 1–2). Vol. 10, No. 2: New Mollusks from the Round Mountain Silt (Templor) Miocene of California. By A. Myra Keen. Pp. 25+60 (plates 3–4). Vol. 10, No. 3: Growth in the Western Blue-Tailed Skink. By Thomas L. Rodgers and Viola H. Memmler. Pp. 61–68. Vol. 10, No. 4: A New Snake of the Genus Sonora from Lower California, Mexico. By Laurence M. Klauber. Pp. 69–70. Vol. 10, No. 5: A Desert Subspecies of the Snake *Tantilla eisenii*. By Laurence M. Klauber. Pp. 71–74. Vol. 10, No. 6: The Coral King Snakes of the Pacific Coast. By Laurence M. Klauber. Pp. 75–82. Vol. 10, No. 7: The Subspecies of the Rubber Snake, *Charina*. By Laurence M. Klauber. Pp. 83–90. (San Diego, Calif.: San Diego Society of Natural History.) [222

Proceedings of the United States National Museum. Vol. 93, No. 3170: The North American Parasitic Wasps of the Genus Tetrastichus—a Contribution to Biological Control of Insect Pests. By B. D. Burks. Pp. 505–608. (Washington, D.C.: Government Printing Office.) [232

Annual Report of the Indian Central Jute Committee for the Year 1942–43. Pp. iii+170 (Calcutta: Indian Central Jute Committee.) [282

Academy of Sciences of the U.S.S.R.: Department of Geological and Geographical Sciences. The Progress of Geological and Geographical Sciences in the U.S.S.R. for 25 years. Edited by V. A. Obruchev. (In Russian.) Pp. iii+200. (Moscow and Leningrad: Academy of Sciences of the U.S.S.R.) [292

Annals of the New York Academy of Sciences. Vol. 44, Art. 5: Sulfonamides. By Colin M. MacLeod, Paul H. Bell, Henry Irving Kohn, J. S. Lockwood, Richard O. Roblin, Jr., James A. Shannon and H. B. van Dyke. Pp. 445–538+4 plates. (New York: New York Academy of Sciences.) [13

U.S. Department of Agriculture. Farmers' Bulletin No. 1945: The Pea Aphid on Peas and Methods for its Control. By J. E. Dudley, Jr., and T. E. Bronson. Pp. ii+14. (Washington, D.C.: Government Printing Office.) 5 cents. [13

Ceylon. Part 4: Education, Science and Art (D). Administration Report of the Acting Director of Agriculture for 1942. By E. Rodrigo. Pp. 16. (Colombo: Government Record Office.) 35 cents. [13

Svenska Hydrografisk-Biologiska Kommissionens Skrifter. Ny Serie, Biologi, Band 2, Nr. 6: On the Biology and Larval Development of *Leander squilla* (L.) forma *typica* de Man. By Hans Höglund. Pp. 44+4 plates. (Stockholm. Svenska Hydrografisk-Biologiska Kommissionen.) [23

NATURE

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ROYAL COMMISSION ON POPULATION

IN 1937 many members of the present Government voted against the Population (Statistics) Bill. Now, after the lapse of only seven years, the Government has appointed a Royal Commission to inquire into the problem of Britain's population (see NATURE, March 11, p. 310). Before the War this vital issue did not receive the attention it undoubtedly deserved ; in general, the country was indifferent, an attitude which was reflected in Parliament when a considerable section of the House of Commons resisted a measure designed to ascertain certain facts essential to any scientific study of the demographic position of Great Britain. It was alleged that the Bill would lead to some infringement of the personal liberties of the subject. Nevertheless, the operation of the Act during the past six years has not, so far as is known, been attended by consequences of this kind, nor has it resulted in any opposition from the general public. Unfortunately, however, the scope of the Act was restricted on account of the reception given it by the House of Commons and by certain sections of the Press, with the result that the facts at our disposal to-day are less comprehensive than they might have been.

It is indeed satisfactory that, despite the debates of 1937 and the subsequent issue in 1942 of a reassuring White Paper on the future trend of population, the Government has changed its mind and has appointed a strong Royal Commission. It will be the task of future historians to identify and assess the influences which led, in the fourth year of war, to this decision. It cannot be due to the trend in the birth-rate since 1937, for it has risen from 14·9 to more than 16·0 per 1,000 population.

The Commission, under the chairmanship of Lord Simon, with its three attendant technical Committees (Statistical, Economic, and Biological and Medical) numbers among its personnel many authorities on demography. The Government is to be congratulated upon the selection that has been made. It may be found in practice, however, not altogether satisfactory that most of these experts have been placed in the technical committees and not on the Royal Commission itself. This may have been thought necessary on political grounds, but, nevertheless, the relegation of the scientific personnel to positions where they may not take part in the study and discussion of the broad issues is not perhaps a very wise arrangement.

The problem of human fertility, though it may appear simple to the casual observer, involves a great many extraordinarily complicated aspects—statistical, medical, social and economic. The Commission, although widely representative as it is, does not include among its membership many recognized students of demography. The Swedes, when they organized their population inquiry, foresaw this particular difficulty and arranged their committees accordingly. Perhaps in the case of Lord Simon's Commission, the problem may be overcome by a

close co-ordination of the work of the main body and its technical committees. This will be necessary unless time is to be wastefully expended on uninstructed debate.

The Commission's terms of reference are exceptionally comprehensive. It is to concern itself with the facts relating to the present population trends in Great Britain, the causes of these trends and their probable consequences, and finally to consider what measures, if any, should be taken "in the national interest" to influence the future trend and to make recommendations.

It is clear that the first task of the Commission will be to establish, and agree upon, the facts. Thus, in the first instance, much will turn upon the work of the Statistical Committee under the chairmanship of Prof. A. M. Carr-Saunders. Before any attempt can be made to extrapolate existing trends—even into the near future—the Committee will doubtless wish to ascertain what has been happening since the first (and only) fertility census for England and Wales in 1911. It has been pointed out that a 60-year decline in the birth-rate was arrested in 1933 and that, as the Minister of Health stated in the House of Commons in July 1943, the rate has since increased. But this does not necessarily mean that there has been a rise in fertility since 1933. The crude birth-rate is a very imprecise measure; it does not take account, for example, of changes in the number of women in the reproductive age groups and the proportion of such women married at each year of life. Due, of course, to the absence of data of this kind, there has been, not unnaturally, some divergence of opinion between different authorities as to the trend of fertility during the past thirty years.

From the statistical information so far made public, it may broadly be said that, before the War, the net reproduction-rate for England and Wales was approximately 0·80; in other words, the number of female births fell short by 20 per cent of the number which, other conditions being equal, would be required to replace in the next generation the women of reproductive age in the present generation. What of course is of paramount importance is the contribution made by women of different ages to this total replacement-rate. What changes have occurred, and are occurring, in the fertility-rates of women aged (say) 20–25, 25–30, 30–35 and so on, according to the proportions married, length of marriage and other factors? Is the present birth-rate being buttressed by an undue proportion of first births to young married women? Or does the rise in the crude birth-rate presage a shift in fertility in favour of larger families to older women? These are the type of problems which it will be essential to investigate if the Commission's work is to rest on any scientific basis.

But these are not by any means the only statistical questions which must come before the Commission. They are, after all, only national averages; and such averages may mask widely different social patterns. Next in order of importance then, as a preliminary to any study of causes and consequences, is the problem of what is known as 'differential fertility'. The reproductive behaviour of various social groups has for long been known to exhibit considerable differences. The inverse association of fertility with social and economic status has for many years been a characteristic of Western civilization. The census for England and Wales taken in 1911 showed, roughly, that the fertility of unskilled workers was about 80 per cent in excess of that for the highest social group. What has happened since 1911? Has the considerable fall in the national crude birth-rate during the past thirty years meant an equalization of the class-rates, or has the decline been disproportionately distributed over the various social and occupational groups? Furthermore, have the regional differences in fertility developed in a similar manner?

If and when the Commission reaches the stage of considering recommendations to reverse the present deficiency in births, the answers to these questions must, it seems, influence their deliberations. Quite clearly different instruments will be needed if some groups in the community are more than replacing themselves while others are far below replacement level, instead of a situation where uniformity in fertility behaviour is generally widespread. Questions of incentives to parenthood, such as a system of flat-rate or graded family allowances, are bound up with the nature of present-day class fertility patterns.

The initial labours of the Commission must, therefore, rest mainly with the Statistical Committee. Some of the information that is needed can be made available, no doubt, by the Registrar-General's Office from the results of the Population (Statistics) Act. But other essential data which are lacking (such as knowledge of class fertility) can only be obtained by fresh inquiries and additional research. It is not clear from the Government's statement whether it is intended to survey and report on what facts are already available, or whether some of the gaps in our knowledge about human fertility are to be closed. It is to be hoped that the Government will not, for the sake of speed, reject proposals for gathering fresh information vital to any adequate survey of such a fundamental problem. It will be better to have a good report in five years time than to appoint another Royal Commission in 1954.

It is stated that the Commission will, at a later date, take evidence on the more general aspects of the inquiry. To enable such evidence to be soundly based, it seems essential that any new statistical material should be made generally available for outside study. It is at this later stage, when the statistical ground has been covered, that presumably the Economic and the Biological and Medical Committees will be actively engaged in studying the problems of causes and consequences. The latter Committee may perhaps at an earlier date be occupied with the much-debated problem of fecundity, that is, the physiological capacity to reproduce.

Some time must elapse, therefore, before the Commission can come to grips with the problem of raising the average size of the family. This issue covers an immense field, and includes practically every aspect of social life from child welfare to education, maternity

provision to family budgets, employment policy to migration, housing to marriage barriers and much else besides. The Royal Commission, in surveying all these factors, will have the advantage of the great amount of research, reflexion and preparation that has gone on in Government Departments in relation to reconstruction. It will be unfortunate if post-war decisions on reconstruction do not take account of the work of the Royal Commission. But as reconstruction must be a process of growth, depending upon the characteristics of the transitional period from war to peace, it may not be too late to shape our post-war plans to influence Britain's demographic future.

THE FOUNDATIONS OF THE DEEP

The Floor of the Ocean
New Light on Old Mysteries. By Prof. Reginald Aldworth Daly. (The Page-Barbour Lectures at the University of Virginia, 1941.) Pp. x+177+12 plates. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1942.) 15*s*. 6*d*. net.

UNTIL the interruption enforced by the outbreak of the War, investigations of the ocean floor and its foundations were proceeding apace with steadily increasing success. In three lectures delivered at the University of Virginia in 1941, and now made available to all in this attractively written and beautifully illustrated volume, Prof. Daly presents a progress report of the detective methods used in probing the secrets of ocean geology and of the spectacular results so far achieved. The three chapters of the book deal in turn with (*a*) the composition and thickness of the sub-oceanic crust and the nature of the underlying substratum; (*b*) the islands, mountain structures and oceanic deeps which diversify the relief of the deep-sea floor; and (*c*) the submerged continental terraces and the mysterious 'canyons' or gullies of the continental slope. The book summarizes clearly and comprehensively a multitude of data not otherwise easily accessible; and it does much more than this, for the author has himself made notable contributions to his subject.

It is pointed out that the detailed investigation of the sub-oceanic crust from records of 'near' earthquakes must await the establishment of an adequate network of seismographic stations located on oceanic islands. Meanwhile, however, the study of long waves (recorded at continental stations after passing through the sub-oceanic crust) suggests in a general way that the rock underlying the central Pacific down to a depth of fifty miles or so is crystalline and has the composition of basalt, and that similar material underlies the other oceanic regions with here and there a thin and patchy covering of sial. The basaltic layer continues beneath the sialic layers of the continents, but, it is thought, with a considerably reduced thickness. From other geophysical evidence, as well as from the geological evidence provided by recently glaciated areas, it is inferred that underlying the basaltic layer there is a very thick substratum of exceedingly weak material. Two working hypotheses are then introduced: that the substratum has the composition of periodotite, and that it is weak because it is too hot to have crystallized. Such a glassy layer would react to earthquake waves as if it were solid, while behaving like a highly viscous liquid towards stress differences of longer duration.

The earth model now favoured by Daly is consistent with a wide variety of phenomena, including the support of great volcanic cones by the strength of the crystalline crust; but it still fails to account satisfactorily for the volcanic activity which built up those cones. Daly's earlier view was that volcanic islands, like the basaltic volcanoes and plateaux of the continents, were fed from a world-circling basaltic layer of which the deeper levels were glassy and therefore eruptible when tapped by fissures. But the idea that the present temperature at the base of the basaltic layer is everywhere high enough to maintain it in a glassy state has had to be abandoned, in face of recent accurate measurements of the heat flow from certain non-volcanic regions. Daly thinks it probable that there may have been a continuous glassy basaltic layer in former geological times, but if such a layer no longer exists it cannot be claimed as directly responsible for present-day vulcanism. The impasse is a very real one, and it should be clearly stated that the whole problem of volcanic activity seems now to be further than ever from an acceptable solution.

Other topics that are capable of more satisfactory treatment include coral reefs and atolls, and the interpretation of the belts of negative anomalies of gravity flanking the East and West Indies as long submarine mountain chains of probably Alpine complexity. Interesting reference is made to the cores of deep-sea oozes brought up from the Atlantic floor by the Piggott boring apparatus; but one misses a discussion of the possible total thickness of the deep-sea deposits. For a solution of this tantalizing problem we shall probably have to wait until sub-oceanic earthquakes can be recorded at nearby island stations. Pioneer studies of the thickness of the continental shelf sediments have already been successfully carried out by seismic methods.

More than a quarter of the book is a masterly description and discussion of the submarine 'canyons' and ridges which have been found to furrow the continental slope wherever its surface has been explored in detail by echo-sounding. These valley-like trenches and gullies have been excavated in the seafloor to depths of as much as 4,000 ft. below the intervening ridges, and some have been traced to depths of more than 10,000 ft. below sea-level. Many hypotheses have been proposed to account for their erosion; but only one, first suggested by Daly himself in 1936 and now more fully developed, appears to be reasonably satisfactory. During the glacial epochs the continental shelf was everywhere exposed. Waves and currents then churned up the muds of the outer part of the shelf and so gave rise to heavy undertow currents of mud-laden water which flowed down the continental slope and eroded chance depressions into deep channels. There is ample evidence, natural and experimental, that the process envisaged by Daly is a real and efficacious one and that its operation in glacial times is correctly dated.

Daly's latest book will be welcomed by a wide circle of readers. As always, he has much to say that is fresh and stimulating. Like Aristotle in an earlier age, he "adds boldness to genius" in synthesizing his facts into a world picture "with due regard to the steadily revised principles of a dozen other sciences".

ARTHUR HOLMES.

PIONEERING FARMING ON A WESTERN SCOTTISH ISLAND

Island Farm

By Dr. F. Fraser Darling. Pp. 224+26 plates. (London: G. Bell and Sons, Ltd., 1943.) 15*s.* net.

THIS book is a record of pioneer farming on the island of Tanera, one of the Summer Islands, lying a little way out from the mainland in western Ross-shire. Here the author and his devoted wife became the owners of an abandoned and ruinous house, and by sheer hard work, without, as the author says, any considerable bank balance to which to turn for comfort, have renovated the land with lime and basic slag, have repaired the ruined quay, have brought the garden again to life, and although their work is not yet completed, have changed the face of the land.

But this book is not concerned entirely with their days on what might be termed their home island, Tanera. There is a most interesting record of a journey to North Rona and a visit to Sula Sgeir. Readers of the author's previous book "Island Years" will remember that Dr. and Mrs. Fraser Darling remained on Rona throughout one autumn in order to study the home-life of the Atlantic seal. The second visit to that remote island fifty miles out into the Atlantic from Cape Wrath was made in the early summer of 1939, when (p. 81) the author found a colony of a thousand pairs of greater black-backed gulls nesting there. This must be the greatest colony of these large predatory gulls anywhere in the British Isles. Here he found the intestines of a bull Atlantic seal, which had died on that island the previous autumn, torn out by the gulls. The sun had dried these intestines—the author measured fourteen yards of them. The gulls had twisted them, time and again, in a fruitless effort to pull them to pieces, and in their twisted state the sun had dried the guts into a rope of great strength.

On Rona the author secured by flashlight what is probably the first photograph ever taken of Leach's petrel (p. 87) in flight.

From Rona a landing on Sula Sgeir was attempted, (p. 91) but was defeated by bad weather. But the author sailed round that rock in a motor launch, and estimated the number of gannets nesting there as four thousand pairs. It is likely that during the last four years the numbers have considerably increased, from Suleskerry Stack.

The main theme of the book is Tanera, an island homely as compared to Rona and no more than $1\frac{3}{4}$ miles from Baden Tarbat pier on the mainland. But even that island can be stormy enough upon occasion. There is a fine description (p. 173) of the great blizzard of January 18, 1941—a storm which I well remember in Skye, for the whole island was isolated by a greater depth of snow than had been experienced there for nearly thirty years. When they were half-way across to Baden Tarbat, the blizzard without warning swept in upon them:

"On Ben More Coigach there were huge plumes of driven snow flying from the several summits and ridges and shining in the sunlight in amazing beauty. Sea, sky and air—all reached a pinnacle of beauty in that moment, but contemplation of it was not my job. I knew that I gazed upon the coming of savagery of the elements, and did then what I have rarely done before: I turned back and berthed the launch before the harbour dried. . . ." When night came and the shutters were put up, "they could do nothing to prevent the terrible noise of the sea and the shaking and creaking of the little house. The byre was filling with snow when I went out to milk".

But even that blizzard was less severe than the one which followed on the night of March 26–27. The following morning, when Dr. Fraser Darling went out, what he saw (p. 176) was most remarkable. In his own words:

"When I went out in the morning I felt dazed, but things of interest revived me in a very short time. I was seeing things I might not see again—at least I hope I shan't. There were wrinkled crabs in the walled garden, not one but a dozen or so, and some were six inches across the carapace. Then I went into the park and found more crabs and many star-fish, and my collie found a ballan wrasse, weighing a pound and a half. The fish, and the crabs, are denizens of the sea just below low tide mark, and here they lay about the grass two hundred yards above the high tide mark. . . . Sometimes I wish I could have seen the great disturbance of the waters of the Anchorage which caused this to happen, and at others I feel that it was just as well to have been in bed."

That tremendous gale actually rubbed the bark from the apple trees, so that "it hung like the velvet from a stag's antlers in August".

Dr. Fraser Darling found (p. 195) that the rats which infest the island eat the pupæ of the green-bottle and bluebottle flies, and also the eggs of the Arctic tern, but are apparently afraid to enter a herring gull colony. The rats also make caches of potatoes up to 20 lb. in weight thirty or forty yards from the nearest row. When the author was trapping the rats he placed the carcases on a rock. The first three mornings the local ravens ate the carcases but never touched them after that: the author deplores the scarcity on his island of buzzards, which would have kept the rats in check.

The tree-planting experiments are interesting. Dr. Fraser Darling planted two hundred Corsican pines (*P. laricio*). Not one survives. We in the treeless north-west coast of Skye planted, as being hardy and salt-resisting, five hundred of these trees. Less than a dozen remain, twelve years after the experiment, and these survivors are barely existing and are no more than six feet high. Dr. Fraser Darling has found that Sitka spruce is the best tree, and this has been our experience also. But I believe that the best tree of all to plant would be Araucaria, the monkey puzzle, for, although not an attractive tree, it seems to be impervious to the salt-laden gales and grows absolutely erect and symmetrical in the most exposed island sites.

There is much interesting farming information in this book. To naturalists the author's account of how basic slag induced a strong growth of leguminous plants, and how those plants attracted the barnacle geese, is noteworthy. He describes in fine poetic prose, (p. 210) how the geese have lost their fear of him and now feed actually in the garden, allowing him to approach to twenty yards of them without fear. A remarkable photograph of the geese grazing illustrates this. A deficiency of lime is found in most soils of the Hebrides. Dr. Fraser Darling advocates the liming of the ground from the coral beaches. He is fortunate in having a coral beach within reach. Where I write, in northern Skye, the nearest beach of this kind (and this has already been almost worked out) is forty miles distant.

Dr. Fraser Darling notes that, in addition to the barnacle geese, many butterflies have been attracted to the land and the cliff's edge through the application of basic slag.

This book is indeed one of unusual interest, written by one who knows his subject as no one else at the present day. It is written simply, and in attractive prose, and is illustrated by some fine photographs, which have resisted the austerity production of war-time. This war production may account for the absence of an index. Seton Gordon.

DISK-HARROWING VERSUS PLOUGHING

Plowman's Folly

By Edward H. Faulkner. Pp. v+162. (Norman, Okla.: University of Oklahoma Press, 1943.) 2 dollars.

Where is the folly? Mr. Faulkner declares it to be with ploughmen who bury green manures, weeds and stubbles many inches below the surface. He is of the opinion that ploughing places such material out of reach of crop roots and creates a sub-surface "blotter" which interferes with capillary movement of moisture. He advocates the use of the disk-harrow as a means of incorporating such materials into the soil surface. If land is prepared in this way, and not ploughed, Mr. Faulkner is persuaded that crop yield may increase five- or ten-fold. By disking plenty of green manure into the surface he believes crop yields can be secured against the vagaries of the weather. According to his predictions, such crops will not be seriously affected by drought, nor, on the other hand, will they suffer in wet seasons. Land drainage would be not merely unnecessary, it would be detrimental to such crops. They would also be practically immune from the ravages of insect pests. Furthermore, Mr. Faulkner is confident that by using the disk-harrow in place of the plough, weeds could be much more easily controlled, provided this practice is adopted over the whole of a considerable area.

All these high hopes have sprung from Mr. Faulkner's experiences in growing vegetables in a garden in 1938 and in growing market garden crops, mainly tomatoes, in 1939 and 1940. No measurements are quoted, presumably because none was made. Mr. Faulkner's folly in committing himself to print on so slender a pretext is infinitely greater than that of any ploughman.

The heavy disk-harrow must be drawn by a tractor. No horse-drawn implement could incorporate a green crop in the soil surface as a tractor-drawn disk-harrow can do it. Mr. Faulkner's thesis that it is better to incorporate a heavy green crop in the surface layer than bury it at plough depth is not unreasonable, and results of independent field trials are quoted in which a fifty per cent improvement in yield was obtained. There is a case for investigation.

Investigation by field trial is inevitably a slow business. The experimentation must be sufficiently extensive both in time and space to cover normal variations in climate and soil. The desire to short-circuit this process is understandable, but should be held in check. The factors influencing plant-growth are many and complex. Patient investigation has greatly extended our knowledge of them in recent years. In the long run, agriculture is best served by using this knowledge to design field experiments.

We do not commit the folly of declaring that no benefit can be derived from disking that could not equally be obtained by ploughing. Traditional methods should be constantly under critical review. It may be that the plough has gained and maintained its favour with farmers on account of the neat appearance of skilfully ploughed land. The awards in ploughing contests have undoubtedly been based on the tidiness of the work. No proof has been sought, and certainly none has been obtained, that land judged to be best ploughed is thereby put in the way of producing the best crops.

Hitherto the record of green manuring in Great Britain has been chequered. On the whole the benefits predicted by its advocates have not been matched by practical results. Admittedly most of these green crops have been ploughed under, not disked-in. Now that tractor-drawn disk-harrows are more widely available, some enterprising farmers in Great Britain will no doubt try their hand at disking-in a green crop without waiting for the results of carefully controlled experiments. Farmers are cautious men, and are not likely to take very seriously the extravagant claims made by Mr. Faulkner. R. K. Schofield.

STARCH

Starch and its Derivatives

By J. A. Radley. (Monographs on Applied Chemistry, Vol. 11.) Second edition, revised. Pp. xii+558+47. (London: Chapman and Hall, Ltd., 1943.) 36*s*. net.

The second edition of this book is an improvement in many respects on that published three years ago. There has been a good deal of pruning of older work now obsolete, and many new chapters have been introduced which deal with a wider field of interest. Some of these have been contributed by recognized experts in the subject. An example of this is the section on the structure of starch which has been contributed by Prof. E. L. Hirst and Dr. G. T. Young. The reader is therefore introduced to some of the newer concepts of the constitution of starch derived from chemical evidence.

It is clear that the author has been at some pains to effect a considerable revision in this edition, and the result is that the monograph has gained in interest both for the general reader and for the expert. Even so, it cannot be said that the present volume provides much more than an introduction to a very complex subject, and, although the attempt has been made to give a critical review of the literature, the selection which has been made is not always well balanced or authentic in the conclusions which are presented. This is perhaps to be expected at this stage of the development of the chemistry of starch, where claims are often made which are conflicting, and where so much that has been written in the vast literature of the subject has to be discarded.

It can be said that the author has made a brave attempt to present in a concise form a very readable account of many of the reactions which starches undergo, and of the industrial and other uses to which they are put. Many readers will be grateful for the opportunity to use this monograph as a guide to the literature of the subject, including the original papers, and for a general survey which brings together much of the research which has been published and which is at present in progress.

GENETICAL CONTROL OF INCOMPATIBILITY IN ANGIOSPERMS AND FUNGI

By DR. K. MATHER

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ALTHOUGH the majority of organisms agree in showing some special control over their breeding systems, whether to encourage inbreeding or outbreeding, they display a great variety of devices by which control is achieved. In most animals the sexes are separate and so self-fertilization is impossible. In spite of this, however, a high degree of inbreeding can be achieved by controlled brother-sister mating, as in the grass-mite; or, on the other hand, inbreeding may be discouraged by various ancillary devices such as the production of unisexual broods or cyclical changes in sex. Discriminative behaviour in mating may also favour either outbreeding or inbreeding, or some combination of the two. In fact, it appears that the controlling devices are likely to depend for their working on any of the special characteristics and faculties of the organisms in question. This is strikingly illustrated in man, whose unique power of combining the transmission of rules of conduct, by means of what has been called tradition, with their enforcement by communal action, is used to govern mating in many different ways to give various degrees of outbreeding. Human matings may vary in advantage for non-genetic reasons in civilized and semi-civilized communities; but the occurrence of mating control even among the most primitive tribes shows that control must have arisen originally for genetical reasons[1].

In plants, as in animals, breeding control abounds, but it depends on a different set of devices. Plants are not mobile, and hence sex separation, or diœcy as it is here called, is not an efficient method of control, for it would involve an undue waste of gametes. Consequently, diœcy is relatively uncommon in plants, which rely on other means of governing the breeding system. Controlled inbreeding evidently may be achieved relatively simply, but outbreeding demands more complex devices[2].

First of all there must be some means of placing gametes from different individuals in appropriate juxtaposition. This may be done by growth of the parent individuals, as in fungi, but it often depends on the use of some intermediary, like water, wind or insects in higher plants. Thus we find adaptations to the use of such intermediaries, especially in the Angiosperms, where, for example, the means of attracting insects to the flowers are both complex and striking. But such adaptations, though clearly essential to outbreeding, will not of themselves suffice to secure its regular occurrence. The mere transport of gametes to another generative structure is not enough, because this structure may not be borne by an appropriate individual. Pollen may, for example, be carried by an insect merely from stamen to stigma of the same flower, or of a second flower borne by the same zygote in the Angiosperms. The plant must, in the last analysis, control the functioning of pollen for itself, if it is to exercise reasonable control of its own breeding. In the same way, though adjacent cells may not achieve fertilization in fungi, separate hyphæ of the same individual may grow together and mate unless some further restriction is imposed.

These further restrictions on inbreeding seem to be imposed in Angiosperms in two chief ways. There may be a time difference in the release of pollen and the receptivity of the stigma, such that certain types of mating are impossible. In protandry and protogyny this time difference will serve mainly to prevent effective pollination within a single flower, where, of course, it is most likely to be brought about; but it is unlikely seriously to hamper pollination between flowers of the same plant—a procedure which in the vast majority of cases has genetical consequences equivalent to those of self-pollination within a flower, as Darwin showed experimentally[3].

The second means of controlling effective pollination in Angiosperms is through the sorting out of the pollen, as delivered to the stigma, by the plant itself, with the prevention of functioning of inappropriate gametes. In fungi the same broad process is seen at work in the aversion, or at least ineffectiveness of contiguity, of inappropriate hyphæ. This general type of behaviour is described as incompatibility and appears to be widespread in the plant kingdom, though it is known by special names in some cases, for example, as heterothally in fungi. The underlying genetical and physiological mechanisms may vary too, but the main principle is always the same, namely, that there exist means whereby an individual, whether haploid or diploid, or even a single gamete, can discriminate for mating purposes among the functional gametes with which it might come into contact.

Incompatibility has been chiefly investigated in the fungi and in the Angiosperms. Discussion must therefore turn largely on the behaviour of these groups. In the former the haploid phase, generally speaking, dominates the life-cycle; though in the Basidiomycetes there is a compromise, a diplophase, with haploid nuclei and diploid cells. In the flowering plants, on the other hand, the haploid phase is so reduced as to be parasitic on the diploid. It is not therefore surprising, in view of the way in which special features of an organism appear to be used, where suitable, in the control of the breeding system, to find that while incompatibility is manifest between haploids in the fungi, the diploid phase plays its part in the Angiosperms.

In the fungi two levels of genetical elaboration may be recognized in the control of breeding[4]. The first involves control by a single gene of two allelomorphs, as in Mucor spp. and Ustilago spp. This prevents self-mating of the haploid, such as would lead to immediate homozygosis, but has no effect on the relative frequencies of homo- and hetero-zygosis following crossings of distinct haploids. In many of the higher fungi, however, greater elaboration is found, the genetical structure comprising one or more series of multiple allelomorphs, similarity for any one of which is sufficient to prevent effective mating. This is interpretable as an adaptation which, in addition to eliminating self-mating, decreases the relative frequency of mating between haploids originating from the same diploid or diplophasic zygote.

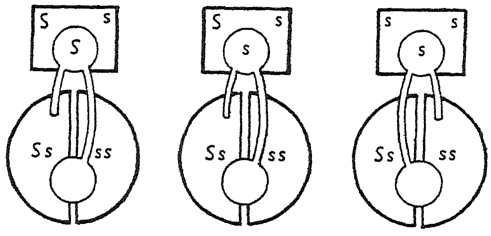
In Angiosperms self-mating of the haploid is ruled out by the separation of sexes between pollen and embryo-sac consequent on the extreme reduction of the gametophyte. The incompatibility mechanism is then concerned with the control of mating between haploids from the same zygote, which it can eliminate altogether and not merely reduce as in fungi. This elimination is achieved by the interposition of diploid somatic tissue, mainly in the form of the style, between pollen and egg. The stylar tissue, and perhaps also other somatic tissues of the ovary and

ovule, acts as a sieve which stops the tubes of certain genetical types of pollen, while permitting others to grow to successful fertilization. It may be noted that although within species the incompatible pollen is that which bears too close a genetical relation to the stylar tissue, the same system may also serve to exclude pollen which is genetically too unlike the female soma, that is, act as an isolation mechanism between species, as in Petunia[5]. Thus we may regard the stylar tissue as primarily a means of regulating the mating system of the plant, able to exclude both the too like and the too unlike (though, of course, other functions in adapting the flower to pollination by particular intermediaries have also developed). The female gametes themselves are protected and conserved in the sense that pollen with which these eggs would, as a general rule, give zygotes of inferior genetical constitution is prevented from achieving fertilization and so wasting the eggs. It is said that in some plants, like Gasteria[6] and the cacao[7], incompatibility manifests itself as a breakdown of development after fertilization. Such a situation can, however, scarcely be described as due to incompatibility in the present sense, for it omits the essential selective advantage of conservation of female gametes, and hence must have arisen in some other way. In fact, it is difficult to see how such a system could arise at all by direct selection. It must be a by-product of some other development[5].

The female haploid of the Angiosperms plays a purely passive part in mating discrimination, except perhaps in situations of the kind supposed to occur in Gasteria and the cacao. If the pollen tube can penetrate the female somatic tissue, it appears not to be repelled by the haploid organs of the embryo sac, and so encounters no further barriers to success. The diploid phase has taken full control on the female side. This is, however, frequently not the case on the male side. In incompatibility of the type first described in Nicotiana and Veronica, and now known to be widespread[8], the reaction is one between haploid pollen and diploid female soma. In all clear cases the genetical control is by a series of multiple allelomorphs, which act in such a way that pollen carrying an allelomorph also present in the stylar and related tissues is discriminated against. Pollen carrying an allelomorph not present in the female soma is not handicapped. It is characteristic of these systems, as of the genetically more elaborate fungi, that there should be a long series of allelomorphs, concerned with normal operation.

There are, however, also cases of Angiosperms in which the pollen grain is not autonomous in incompatibility. These are mainly afforded by heterostyled plants, though *Capsella grandiflora*[9] shows the same property without any morphological variation. In Capsella and distylic plants, such as the many dimorphic Primulas, the reaction of the pollen is most simply regarded as determined by the genotype of the soma which bore it. In Primula species, for example, the thrum type is heterozygous, *Ss*, and the pin type homozygous, *ss*, for the controlling gene. The *s* pollen of a thrum fails on an *Ss* style, where the *s* pollen of a pin is successful, but is successful on an *ss* style, where the pin *s* pollen fails. In other words, the male and female somata must be genetically unlike for success, the genetical constitution of the pollen being immaterial (Fig. 1.)

This simple interpretation breaks down with tristylic species, such as *Lythrum salicaria*, for here the position of anthers and stigmata in the flowers comes

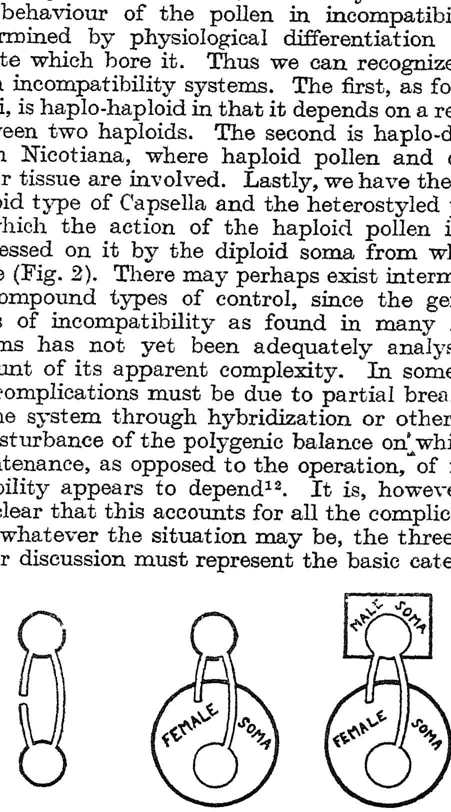


Thrum *Ss* Pin *ss*.

Fig. 1. Diplo-diploid control of incompatibility in Primula. Success or failure of the pollen (upper circle) in fertilizing the egg (lower circle) depends on the relations existing between the genotypes of the male soma (rectangle) and female soma (half circles). The genotype of the pollen itself plays no part in determining the reaction.

into play in a more striking way. A given flower produces pollen at two levels and each level has its own characteristic and distinct properties in incompatibility[10]. Thus the effect on pollen behaviour of the male somatic genotype is not so important as the immediate effect of the male soma where the pollen is borne. The behaviour of certain homostyled types of *Primula sinensis* suggests that the same mechanism may be operative in distylic species[11], but here, however, differentiation between the two possibilities is not final.

Whatever the mechanism of action of the male soma may be in such cases, it is at any rate clear that the behaviour of the pollen in incompatibility is determined by physiological differentiation of the zygote which bore it. Thus we can recognize three main incompatibility systems. The first, as found in fungi, is haplo-haploid in that it depends on a reaction between two haploids. The second is haplo-diploid, as in Nicotiana, where haploid pollen and diploid stylar tissue are involved. Lastly, we have the diplo-diploid type of Capsella and the heterostyled plants, in which the action of the haploid pollen is that impressed on it by the diploid soma from which it came (Fig. 2). There may perhaps exist intermediate or compound types of control, since the genetical basis of incompatibility as found in many Angiosperms has not yet been adequately analysed on account of its apparent complexity. In some cases the complications must be due to partial breakdown of the system through hybridization or other cause of disturbance of the polygenic balance on which the maintenance, as opposed to the operation, of incompatibility appears to depend[12]. It is, however, not yet clear that this accounts for all the complications. But whatever the situation may be, the three types under discussion must represent the basic categories,



Haplo-Haploid. Haplo-Diploid. Diplo-Diploid.

Fig. 2. The stages in control of incompatibility by the diploid phase. In the haplo-haploid, incompatibility depends on the genetical relations of two haploid cells; in the haplo-diploid, on the genetical relations of haploid pollen and diploid female soma (the egg being passive); and in diplo-diploid on the relations between male soma (the reaction type of which is impressed on the pollen it bears) and female soma.

and all the cases which are fully understood fall into one or other, with or without some breakdown.

As we have seen, normal operation of the haplo-haploid and haplo-diploid types is characteristically controlled by series of multiple allelomorphs. The diplo-diploid, on the other hand, has a simpler genetical control. There are never more than two allelomorphs of any one gene operative in the normal system (multiple allelomorphism may be involved in breakdown), though a little genetical elaboration may be introduced by the operation of two loci, as in Capsella and Lythrum[13]. My colleague, Dr. D. Lewis, has pointed out that this difference in genetic control is probably a reflexion of the two types of gene action involved. In the haplo-haploid and haplo-diploid each allelomorph may be regarded as essentially individualistic in action, for only a single allelomorph can be operative in any one reaction. Hence no question of combining and co-ordinating the action of two allelomorphs arises, in the way that it must with the diplo-diploid system, which may thus be physiologically restricted.

The three types of incompatibility systems form a series of increasing control by the diploid phase. Is there any corresponding increase of efficiency and advantage to the plant ? It is not difficult to see that the intervention of the diploid phase on the female side is advantageous. Haplo-haploid control can prevent inbreeding at the first and most extreme level, namely, self-mating of a haploid leading to immediate homozygosis ; but it can never wholly eliminate the occurrence of inbreeding, at the second or zygotic level, by mating of haploids from the same parent zygote. This may be of lesser importance in fungi, where the spores of a zygote are broadcast widely ; but in an Angiosperm it is a matter of considerable moment because self-pollination, leading to mating of male and female haploids from the same zygote, may be unduly common unless restricted. The interposition of the style in the incompatibility system allows of complete elimination of this contingency, if advantageous, with the result that inbreeding is controlled at the zygotic level.

The second difference in the degree of diploid control, that on the male side, seems to lead to no increase in efficiency. The suppression of inbreeding at the zygotic level is achieved by the action of the diploid style, and given free dispersion of pollen and seed the prevention of self-pollination ensures maximum outbreeding. Breeding systems must be regarded as essentially adjusted to controlling the degree of heterozygosis of the population[14], and the maximum heterozygosis obtainable for all the genes of an organism by this means alone is that given by random mating. Higher values of heterozygosis can be obtained if mating of homozygotes is restricted in highly specific ways, but these are extremely unlikely to be found in Nature for any but special genes such as those which control the breeding systems themselves. Permanent heterozygosis also occurs in Oenothera, for example, but balanced lethals and ring-formation are involved in the mechanism, which thereby does not depend solely on the breeding system in the way we are discussing. Thus, so far as mating control is concerned, inbreeding in flowering plants is largely a matter of self-pollination. Indeed, as measured by Wright's inbreeding coefficient[15], the rate of inbreeding may be calculated to a first approximation, the adequacy of which depends on the adequacy of seed and pollen dispersal, from measurements of the natural rate of self-pollination.

From this point of view the haplo-diploid system is no less efficient than the diplo-diploid, for both can give maximum outbreeding, namely, effectively random mating in all but the smallest populations. Indeed, where pollen and seed dispersal are not free, haplo-diploid systems may have an advantage over the diplo-diploid as we know it, since the multiple allelomorphs of the former permit somewhat freer mating between non-sister zygotes than between sisters. This superiority of control at the third, or sibling, level of inbreeding seems, however, likely to be an advantage too trivial to warrant consideration at the present stage of analysis ; but a second potential disadvantage of dependence on two allelomorphs is more serious. In distylic plants, with one gene of two allelomorphs, any individual can mate successfully on the average with only one half of its fellows. In tristylics this fraction is raised to something like two thirds, but in the haplo-diploid system, with many allelomorphs, the effective fraction must approximate closely to unity. Thus mating efficiency is higher and gametic loss lower with a haplo-diploid control, though the gametic loss is perhaps somewhat reduced in the diplo-diploid type by the heterostyly with which it is so regularly associated.

The diplo-diploid system has, however, one compensating advantage, in that the haplo-diploid requires a minimum of three allelomorphs for its operation whereas the diplo-diploid requires but two. For this reason it may well be that the genetical situation necessary for the origin of a diplo-diploid control is simpler and more likely to occur than that for the haplo-diploid. In view of this it seems that diploid and haploid controls of the incompatibility reaction on the male side cannot on balance differ markedly in the relative advantages which they carry. This is in sharp contrast to the corresponding situation on the female side, where the advantage of diploid control by the interposition of the style is always clear in affording the possibility of eliminating mating between both the too like and too unlike. It is thus not surprising that the structure through which diploid control on the female side is exercised should be a universal feature of the higher plants, whereas there is apparently no corresponding uniformity of control on the male side. Perhaps if a form of male control should arise, combining the ease of origin of the diplo-diploid type with the efficiency of operation of the haplo-diploid, it would supplant both the existing types. Such a system would presumably use both the multiple allelomorphs of the haplo-diploid and the co-ordination of gene action necessary to impress a somatically determined behaviour on the male gametes in the way shown by the diplo-diploid. It is, however, not yet clear how, or even whether, such a system is a developmental possibility.

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THE ILLUSION OF PERSONALITY*

By H. G. WELLS

THE integrality of the individual in the higher Metazoa is a 'biologically convenient delusion'. The expression 'psycho-analysis' implies a mental unity which can undergo analysis. This is the delusion. The reactions of the human machine are loosely linked behaviour systems, participating in a common delusion of being the self. Most lower animals react to stimuli without hesitation. As we ascend the scale *inhibition* appears. There is no longer a mere algebraic summation of stimuli. There is reference back to a storage organ, a 'brain'. According to the record of that storage organ, the organism, not as a whole but as much of it as is affected by the recorded stimuli, reacts. Circumstances may have changed and it may act disastrously, or it may 'profit by experience'.

The *conception of self* appears most evidently in gregarious animals, which have to conduct themselves with regard to the flock or pack. The sub-men seem to have been gregarious running animals, less like the solitary great apes than the baboons. Self-consciousness and a conception of other individuals as consistent persons are necessary to gregariousness. The self-conscious social individual, *whatever it does and however much of it does it*, will ascribe its behaviour to its self, the same self, in continuous operation.

A man awakening from sleep imagines, when he has rubbed his eyes and yawned, etc., he is 'all there'. He is not. The evanescent impressions of dreamland give way to a more vivid reaction-memory-and-event-system which has established a by no means perfect control over what are called the voluntary muscles of his body. Body holds mind together and not mind body. The body goes as the dominant system in the neuro-sensitive apparatus directs, but other reaction systems are either deflecting or ousting the dominant system.

There are endless variants of 'John Smith'. He will admit in ordinary speech that he 'has his moods' and sometimes 'forgets himself'. It is John Smith No. 214, John Smith who had a dispute with his employer yesterday, who wakes up, the indignant employee. He rehearses a spirited conversation with his 'gov'nor'. He sees his wife's portrait on the mantel and succumbs to resentment and jealousy. The recalcitrant employee is simply not present. John Smith, under control of No. 618, goes down to breakfast in a dark, unloving mood. All the Smiths, from No. 1 to No. 5,000 or No. 5,000,000, have a common belief that John Smith is really one person, because they are not only all aboard the same body, but also built round a similar conception of himself, his *persona* as Jung has it. *In fact, they are a collection of mutually replaceable individual systems held together in a common habitation.*

If the systems vary widely, John Smith is a moody man. If still more widely, you have at last a 'double personality'. Whatever system dominates at the time owns John Smith and believes itself to be wholly and solely John Smith.

Conduct systems of reaction require a fable to hold our *selves* together and put them over to others. The neuro-sensitive apparatus in social animals cannot do a thing and forget, cat-fashion. Our conduct systems, whenever they invade simpler systems of reaction in us, set about attacking the independence of these other impulses and drawing them together. They go about like governesses, drill-sergeants, imposing an impossible uniformity of discipline upon the mute unconscious elbowing of our other drives and reactions.

In order that the *persona* should be as consistent as possible in its autobiographical effort, these conduct systems, which concern themselves with the reputation of a human body, ignore aberrant impulses, push them away into what the analyst calls the unconscious, that is, a multitude of reaction systems out of contact with the main directive system. The psycho-analyst says they are below in a dungeon ; the behaviourist says they are at large outside. The contradiction is flat.

Jung called this excluded stir the *anima*. It may contrast markedly with the material in the *persona*. It stirs, says the psycho-analyst, beneath the conscious life. It skulks, says the behaviourist, on the edge of the waking life.

That the integrality of the human individual is illusory does not sweep aside continuity from life. The individual belongs to his species, which existed before he appeared in the world, and will outlast him. Generally a man does not realize that. He may refer himself to a family, to a tribe, to a school, to a real or imaginary 'race', to a creed—indeed to a vast variety of larger aggregations. He may fluctuate in his terms of reference. So he thinks and feels. The biological reality is that while he can interbreed with every variety of human being, he goes on as a unit in the whole species, and, whatever frame of community he adopts, it can, from the ecological point of view, have no narrower boundary than the species. Every individual is in the nature of a unique experiment. There is no experimenter nor question behind it ; it is an unpremeditated experiment.

It may be rejected at once ; or it may have survival value in itself. By surviving it changes the totality of the species by its individual difference. In the generality of cases the difference is slight, and such individual cycles are called *normal*. Their collective effect is that of confirmatory experiments.

A marked and sudden difference is called a variation. The causes of a variation will almost certainly be acting not merely in one case but also upon groupings of similarly situated genes. So long as the individual variation has the qualities that enable it to survive and reproduce itself it will do so.

There is no benevolent bias in that survival. A species may go on varying and surviving through its individuals for a long time, although it is accumulating a variation that will disarm it against some conclusive danger. Most variations have no survival value at all ; but when a species has drifted into disharmony with its surroundings—and that is the case with ours at the present time—then abnormalities which would have been suppressed in the humdrum days of security may stand a chance of temporary establishment. Palæontology shows repeated evidence of a sort of flurry of abnormalities before the collapse and obliteration of some dominant group which has outstayed its welcome. This seems to be the case with man to-day.

From its first appearance, the human animal was too widespread and too thinly spread to produce a

* An abridgment of a thesis on "The Quality of Illusion in the Continuity of the Individual Life in the Higher Metazoa, with particular reference to *Homo sapiens*", accepted for the doctorate of science of the University of London. Copies of the complete thesis are available to scientific institutions free of charge ; otherwise it is two guineas unsigned, which will be devoted to the propaganda of the Natural Rights of Man, of which Mr. Wells is acting secretary.

homogeneous *Homo sapiens* throughout the earth. There has been more homoplasy and less of diffusion in Homo than is commonly believed.

Migrations began only in the past ten thousand years or so, when the social structure had developed means of conquest and exploitation. At a far remoter period exiguous human races ranged seasonally over wide territories, incapable, for lack of transport or organization, of sustained aggression or enslavement. The seasonal movement of gregarious food animals, horses, cattle and the like in response to pasture may have led to seasonal gatherings of these far-flung tribes from considerable distances, with little or no spirit of feud or aggression.

The leavings of Solutrean men suggest a gregariousness in which the individuals were more self-reliant and socially tolerant than their descendants. These early nomads exchanged goods at these primordial fairs, as the distances of many early artefacts far from their sources testify. With the dispersal of the food beasts this human gathering dispersed again, with quite possibly a woman or so and an artificer going off with a new party. He or she would not need to learn a new language, when grunts and gestures remained the language of mankind.

Time estimates of these periods defeat even geologically trained imaginations. Our grip on big quantities is a feeble one. We have got beyond any other animals by checking with our digits, but our sense of a hundred is foggy, and few will agree whether a crowd was a thousand or three thousand strong. Beyond these limits we *concertina*. We have a 'gibus' sense of time. A thousand years is a huge succession of yesterdays beyond our clear apprehension. If we reflect on the changes in social life since the Christian era, we may achieve an intellectual if not a realistic comprehension of the remoteness of these wanderers from whom we spring. Many people believe that our ancestors were like the Australian aborigines. These 'primitive peoples' are imagined as having been marking time for a hundred thousand years. But in that interval they have been subjected to climatic changes, changes of food, new environments. They have experienced dark ages and phases of recovery. Anthropologists underestimate the intervals in which these systems have decayed and revived and changed and become something quite different. The 'primitive' Australian *talks*, and he has a complex grammar. He betrays traces of admixture, and, if we bring geographical shifting into consideration, we are forced to conclude that in the past there must have been trading, a 'pigeon' language, and ideas and imitative stimuli from other drifting peoples. One may doubt if one can exaggerate the mental remoteness of these creatures whose lives are the basis of our thought and feeling. The makers of eoliths and of Chellean implements gave place to Acheuleans, to Mousterians, to Aurignacians, Solutreans and Magdalenians. Meanwhile every species of large animal contemporary with the Acheulean had become extinct. Can we imagine, then, that the ascent of man has been simple and straightforward from Neanderthal to Beckenham, Paris and the Riviera ?

We make our way painstakingly to the fact that the mind of ancestral man was essentially unlike ours, and that the species was living under conditions still mostly unimaginable. He was not only different from anything human we can talk to, but, from the very beginning, he was also different *inter se*.

A species is a species so long as it can interbreed and its kindred varieties, however divergent, can be recognized. There never was an original dog. Dogs are anything but select in their emotional phases. If an end came to dog fanciers, Canis would go back to a variety of mongrels, reflecting the regional opportunities in which they found themselves.

Gregariousness is a subordination of the individual to the herd. The individual merges into a wider synthesis, a vast sentient web overspreading many acres; becomes shareholder in faculties always awake, eyes that see in all directions, ears and nostrils that explore a broad belt of air; a super-individual occupying every bit of ground whence the approach of an enemy can be detected. Each individual receives a maximum of security at the cost of a minimum of individual animation. When an animal which has been accustomed to a gregarious life is isolated, it feels itself exposed to danger from every part of the circle around him, except the one point on which his attention is momentarily fixed. His glance is restless and anxious, and is turned in succession to different quarters; his movements are hurried and agitated, and he becomes a prey to the extremest terror. The blind instincts evolved under those conditions have been deeply ingrained into our breed, and they are a bar to that freedom the forms of modern civilization could assure. A modern community must be held together by stronger forces than are derived from the purely gregarious instincts. It cannot be a mob of slaves, clinging together, incapable of self-government and begging to be led; because it will always be led to disaster. It must consist of vigorous, self-reliant men, knit to one another by a strong, tense and elastic community of will and understanding.

The personal life of the individual will still continue, held together by the individual body. Within its conditions that may be a very intense and passionate existence. Many of the bodily phases that constitute John Smith may be preoccupied with sex. The sexual stir of the contemporary Homo is renewed monthly, unlike so many of the larger Eutheria, which have their annual rut. These phases are dependent upon the secretion of gonads, which again seems to be determined by the fluctuations of innate rhythms under climatic and correlated physical influences.

There has been an enormous and biologically unserviceable over-development of those aspects of life in the handy and intelligent Primates. The release of hand and brain by the adoption of the erect attitude during the human dawn, and the revival or continuation of some primitive monthly breeding cycle among the sub-human and human series, stimulated a recurrent or almost continuous interest in the orgasm that is only too manifest in a cageful of monkeys or any over-fed and idle social group—both confined and unemployed groups. But while the monkey's interest is unabashed, contemporary man is in a state either of defiant indulgence or passionate suppression that disorders all his social life. Christianity, Islam and Judaism are all phallic religions, and 'morality' over a large part of Christendom means nothing more than values attached to sexual behaviour.

But we do not know how long this stress on sex as 'morality' has lasted. Dawning man, except under deprivation, may have been as shameless and casual as a monkey. Those primordial fairs were amiable corroborees, free of competitive or possessive ideas. We may describe man, in those sparse days, as under-

sexed. The male and the female of the species excited one another and achieved a mutual or substitutional relief; it was all over in no time, and that was all about it. The manner in which the sexual urge lies in wait, so to speak, and seizes upon and makes use of any unemployed mental energy in *Homo sapiens* has still to be worked out in detail.

There have been and still are wide and rapid variations in the relationship-phases of men and women, and nowadays a woman will be either a subjugated meretrix or a hard-minded and responsible equal, just in the measure that her sexual impulses and status dominate or are secondary in her *persona*. The decision rests upon womankind and the atmosphere they will create.

Every living thing, in obedience to its hormic urge, seeks to assert itself over other things that move about—over other life or over inanimate things that are imagined as having life. "This," in effect says life, emerging to a consciousness of others, "is not going to beat me." This primitive uneasiness to reassure oneself that one has the upper hand of the not-me is still far more persistent than any other urge. We assert these selves through a huge miscellany of claims. The claims we make depend upon our upbringing and the ideas imposed on us. We pride ourselves on 'race', country, class, family, 'set' or dollars, intuitions, exceptional muscles or remarkable characters. We gravitate to the groupings in which these are key values.

Man in his dawn was certainly not so collectively maladjusted as the man of our own time. Contemporary man *en masse* is definitely a degenerate creature, in the sense that he presents no collective resistance in the face of change. He experiments only feebly in adaptation; he persists in his follies.

But since we have some two thousand millions of him varying about the average cases *of any particular quality*, whatever it may be, the exceptional instances are likely to have a wider range than in any previous period. These exceptional types will include, among others less biologically favourable, types of self-forgetfulness in some impersonal interest.

The factor in the individuals of this emergent *élite* is a development of the natural curiosity, the picking and searching hands and eyes of our ancestors. The dominant phases of the unrestrained man, as distinguished from the suppressed individual in our now disintegrating modern communities, are those of an inquirer and maker. His unrestrained phases discover an innate desire for mastery; in invention (artistic or 'practical') and construction, according to his aptitude. The profounder disposition of mankind is to make, and to sublimate self in the discovery, each man, of his own idiosyncratic creative possibility.

In the case of an intellectual *élite* there will be recurrent phases in their lives when an ecstasy of discovery will possess them. They will stand "silent upon a peak in Darien". They will be looking upon something, hitherto hidden, which will now be the property of all mankind. They must descend again from that great moment into the shadow of their personal selves, but the achievement will remain as an enduring contribution to the human synthesis.

The spreading realization that personality is illusory will not abolish the practical reality of individual living. This warp and woof of hallucination provides the fabric on which lives are lived, just as the cinema screen supplies the fabric on which personal dramas are played out. To realize that the drama is hallucinatory will be to escape from ultimate 'explanations' of life, from priestcrafts and mental muddles that have embittered human relationships hitherto, but it will not release human beings from 'conduct'. It will, however, lift them into a new atmosphere, and mitigate profoundly the confused motivation of that long "Martyrdom of Man" which is now drawing to an end.

OBITUARIES

Sir John Farmer, F.R.S.

By the death of Sir John Farmer on January 26 biology has lost an outstanding figure, one who did much for the development of botany and for the extension of its applications.

John Bretland Farmer was born on April 5, 1865, at Atherstone and was for a time at the Atherstone Grammar School, but was later educated privately. A country upbringing and a knowledge of the farmer's outlook was of great value to him in his later efforts to use botany for the advancement of agriculture. He went to Magdalen College, Oxford, in 1883, and took a first-class in the Honours School of Natural Science in 1887. In that year he was appointed demonstrator in the University, for Bayley Balfour, who was then Sherardian professor of botany, early recognized Farmer's intellectual gifts and fostered his botanical development in every way. Farmer would often speak in warm tones of the inspiring influence of his old teacher, who was both botanist and gardener. In 1889 he was elected to a fellowship at Magdalen.

When Huxley retired from the headship of the Biology Department of the Royal College of Science at South Kensington the chair was replaced by two assistant professorships, the botanical one being filled by the late D. H. Scott. When Scott retired in 1892 he was succeeded by Farmer, the position being raised to a full professorship in 1895. Farmer remained at South Kensington for thirty-seven years, retiring only in 1929.

Farmer's long period at the Royal College of Science (later to become an integral part of the Imperial College of Science and Technology) was one of remarkable development and expansion of the department. In Farmer's early years at South Kensington the department was housed in two rooms at the top of the building in Exhibition Road and the staff was a professor and one demonstrator. When he retired in 1929 the department occupied two large buildings in Prince Consort Road and consisted of five sub-departments, each with a professor at its head.

Farmer was not only a scientific investigator but also a man of vision who had his own distinctive idea as to the direction in which the department should develop. Fifty years ago academic departments of botany held aloof from the practical application of their subject. Farmer, however, early realized how much trained biologists (plant pathologists, geneticists and plant physiologists) could do not only for agriculture in Great Britain but also for the plantation industries overseas and for tropical agriculture generally. He therefore set himself to provide such a training in pure botany as would equip men for work in applied botany abroad. This aim he fully achieved and his students were soon occupying important positions in Colonial agriculture. Some measure of his success may be gathered from the

testimonial given to him on his retirement. Of the old students subscribing, fifteen were in India, ten in Africa, seven in the British West Indies, seven in the Federated Malay States and Borneo, six in Egypt, five in Ceylon and a number in Australia, New Zealand, Burma, Iraq and Japan.

In the pursuit of these aims Farmer did not, however, allow the torch of pure learning to be dimmed. He had wide interests in botany and published work in various fields, and he did distinguished work as a cytologist before the boundary between cytology and genetics had broken down. In 1907 he gave the Croonian Lecture of the Royal Society—of which he had become a fellow in 1900—his subject being the "Structural Constituents of the Nucleus and their Relation to the Organization of the Individual". He received a Royal Medal in 1919 and was a vice-president during 1919–21. Farmer was a writer of clarity and directness, qualities which he himself ascribed to a youthful drilling in Latin. He wrote several smaller books on elementary botany and with A. D. Darbishire edited the translation of "Die Mutations Theorie" by de Vries. He organized and during its early years was editor of *Science Progress*. He edited also the *Gardeners' Chronicle* during 1904–7 and for a number of years the *Annals of Botany*.

Farmer, with his broad scientific knowledge, his grasp of affairs and his powers of decision, was naturally in great demand where the organization of what might be called plant technology was concerned. He was a member of the small Inter-Departmental Forestry Committee, on the report of which the Imperial Forestry Institute was founded. He served on the Milner Committee, and played a large part in the establishment of the Imperial College of Tropical Agriculture in Trinidad. He was a member of the Advisory Council of the Department of Scientific and Industrial Research from 1920 until 1926, and it was during that period that the Forest Products Research Board was organized, and he was its first chairman. To the Empire Cotton Growing Corporation, especially in its early years, Farmer gave notable service. On behalf of the Corporation he and Mr. L. G. Killby visited Trinidad in 1925, and as a result of their report the Cotton Research Station was set up in 1926. He also gave invaluable advice and help when the Corporation established a postgraduate studentship scheme for the recruitment of its staff. Later he was to serve on a committee set up by the Secretary of State for the Colonies to inquire into the training of agricultural officers for the Colonies. Farmer, from his experience of the Corporation's scheme of postgraduate studentships, advocated a similar one for the Colonial Office. As a result of the Committee's report an entirely new scheme of recruitment for the Colonial Agricultural Service was established. Farmer's advocacy was of the greatest value, for the scheme brought about an almost revolutionary improvement in the qualifications of the Colonial agricultural officer. Farmer was active in many other ways—as a member of the Research Committee of the Rubber Growers' Association, of the Royal Commission for the Exhibition of 1851, and of the governing body of the Imperial College, on which he served from its establishment in 1907 until his retirement. He was knighted in 1926.

Farmer was a man built on generous lines both in mind and body. He stood well over six feet, and the big muscular hands of his large-boned frame were equally good at cutting a botanical section, tying a fly, or giving confidence on the rope to the tyro whom he was instructing in the craft of rock climbing; for he was botanist, fisherman, mountaineer and, not least, gardener. In all these pursuits Farmer was the born teacher, always ready to pass on his knowledge, and delighted if he could inoculate others with his enthusiasm. Farmer was a steadfast friend, and since to a knowledge of men and affairs he added the quality of 'allroundaboutness' of outlook, one could go to him in a difficulty with the certainty of receiving counsel of rare balance and wisdom.

V. H. BLACKMAN.

Prof. J. W. H. Eyre

BRITISH bacteriology and Guy's Hospital both lost an outstanding personality when Prof. J. W. H. Eyre, emeritus professor of bacteriology in the University of London, recently died at the age of seventy-five. Entering Guy's as a medical student in 1889, he qualified in the minimum time, graduated M.D., M.S., in the University of Durham and received his first hospital appointment. This initial experience as registrar in the Ophthalmic Department was an appropriate introduction to the delicate, small-scale experimental laboratory work to which he was later to devote his life. In fact, his first research, though ophthalmic, was essentially bacteriological, culminating in his description of tuberculosis of the conjunctiva which stands a classic to this day. At that time (1895) all hospitals, realizing the great future of medical bacteriology, were developing laboratories accordingly, and inevitably Eyre was attracted by this new trend. In 1899 he gave up eye work entirely for the post of bacteriologist to Charing Cross Hospital, where he became the first Ernest Hart Memorial Research Scholar and at once began to devise new technical methods, and showed such genius for the work that three years later he was invited to occupy the corresponding post at his own hospital. He never again left Guy's and there centred the whole of his remarkably industrious and productive career.

In 1905 he was invited by the Royal Society to join the Advisory Board of the Commission on Mediterranean Fever. Working overseas as chairman of the team experimenting in Malta he was associated with a number of results which did much to advance our early knowledge on Brucella infections and paved the way to their ultimate control. Returning home he resumed his former work of bringing law and order into the still somewhat chaotic state of routine bacteriological investigation, and shortly after published his standard work, "The Elements of Bacteriological Technique", which, when consulted to-day, shows us his pioneer conception of a remarkable number of modern methods. About this time he was elected a fellow of the Royal Society of Edinburgh. Soon, bacteriological diagnosis becoming more accurate, he found it possible to give his research a more direct medical bearing, and over this period he published with his clinical colleagues many case notes on infective disease.

Most notable, perhaps, was his work on the varieties of pneumococci associated with different respiratory infections, a true forerunner of later developments, and also his proof that much institutional dysentery was really of the Flexner type. Meanwhile the amount of work entering the laboratories at Guy's was increasing so rapidly that the Governors of the Hospital wisely decided to develop a new and completely up-to-date department. This they entrusted to Eyre,

giving him an entirely free hand, and the result was possibly one of his major contributions to his subject. For many years his laboratory stood as a model for others, both as to its design and its system of records, references and accounts. It was, in fact, still meeting every demand made upon it even at the time of his retirement twenty-five years later, a remarkable example of his exceptional skill as organizer as well as scientific worker. Its opening coincided with the outbreak of the War of 1914–18, and as might be expected, although the Department was never under direct Government control, a very large amount of work directly aiding the Services passed through it. Eyre's peace-time activities had brought recognition in the form of appointments as Erasmus Wilson Lecturer and Hunterian Professor at the Royal College of Surgeons and Milroy Lecturer before the Royal College of Physicians.

The moment war broke out he placed the facilities of the laboratory at the Government's disposal, and the first big work undertaken concerned the urgent task of systematically detecting the many typhoid and paratyphoid carriers returning from the British Expeditionary Force. Methods were standardized and compared and a complete system instituted which must have prevented many home outbreaks. In 1915 Eyre was appointed as a civilian pathologist in the London District Command, and co-operated in improving and selecting the various anti-enteric vaccines which later proved so successful in France. Then the second great war-time infection threatened, namely, cerebro-spinal fever, and his laboratory again was active in investigating both meningococcal carriers and acute infections. It is interesting to note in his reports of those days how he insisted, and was ultimately proved correct, that cerebro-spinal meningitis is primarily a septicæmia. A little later, these urgent investigations being over, Eyre turned his attention to the then somewhat inadequate bacteriological facilities available to the many semi-private military hospitals which were springing up all around London, and we find him displaying really astonishing energy as honorary bacteriologist to a very large number of them. Military, Royal Flying Corps, and American units were included, and the volume of personal work he must have got through at that period was enormous.

When the influenza epidemic attacked Great Britain, Eyre at once found himself involved in the investigation of the prevailing secondary respiratory tract infections and the possibility of preventing them by prophylactic vaccine. In this case he was particularly concerned with the New Zealand Forces, and at one period his Department placed half a million doses of vaccine at the disposal of the Army Medical Department of the War Office inside seven days. Records show how greatly this work must have reduced the incidence of complications. In April 1918 he was invited to join the Trench Fever Committee of the War Office and co-operated in proving this disease to be louse-borne, although the War ended before the exact nature of the organism could be determined. His final war-time contribution was as a member of the Chemical Warfare Committee of the Medical Research Council, the work of which guaranteed our preparedness in that sphere at least.

The return to peace conditions called for considerable departmental reorganization, and Eyre's was one of the first to get into its stride again. A rapidly expanding venereal disease clinic at his hospital brought new volumes of serological work, and he was concerned with many serial observations on the comparative value of the Wassermann reaction and the various flocculation tests for syphilis. Also Sonne dysentery was coming to be recognized as a real threat to institutional life, and one of the earliest fully recorded outbreaks was observed in his laboratory.

Having held a readership for many years, Eyre was in 1920 appointed professor of bacteriology in the University of London, and from then onwards his activities in medical societies and committees became even greater. He had been president of the Section of Bacteriology and Pathology at the British Medical Association meetings of 1933 and became president of the Royal Microscopical Society in 1920. Later he held the same office in the Hunterian Society and the Royal Institute of Public Health and Hygiene. He attended many overseas meetings and was well known on the Continent. His editorship of the English translation of Kolle and Hetch's "Experimental Bacteriology" was admirable.

Although the scientific world will remember Eyre chiefly as an inventor of technique, his colleagues at hospital always realized that he had considerable clinical gifts. He was always about the wards and his advice freely taken. He produced with Dr. Bosanquet a most useful little manual, "Serums, Vaccines and Toxins in Treatment and Diagnosis". The passing years never seemed to affect his remarkable energy, and his strong personality carried him along, always in harness, to the very end. An interesting appointment which he held for a good many years was that of bacteriologist to the Worshipful Company of Fishmongers, and he may be said to have thereby controlled the bacteriological purity of the nation's fish supplies, doubtless preventing innumerable epidemics. But this work had its essentially scientific side also, and he produced several beautifully illustrated monographs on the bacteriology of the edible molluscs.

His colleagues at Guy's will always remember the minute, neat, intensely active figure of "Johnny" Eyre. Everyone knew, honoured and loved him and, when he retired from the active staff of the Hospital in 1934, gave him a memorable farewell dinner. But he never entirely deserted his Medical School, and was seen about the laboratories less than a week before his tragically sudden death. Those who actually worked with him will greatly miss the inspiration which he always gave to them and his unfailing interest in the welfare of everyone ever connected with his old Department. There are many working in the medical laboratories of to-day who, for the excellence of their earlier training, owe him a very great debt of gratitude. F. A. KNOTT.

WE regret to announce the following deaths:

Dr. J. McKeen Cattell, editor of *Science* since 1894, and also of other American scientific journals, on January 20, aged eighty-three.

Mr. A. W. Clayden, principal during 1894–1920 of University College, Exeter, known for his reports to the British Association on the measurement of cloud altitudes, aged eighty-eight.

Mr. A. Eidinow, of the National Institute for Medical Research, London, known for his work on the principles of ultra-violet ray therapy, on March 22.

Dr. James H. Kimball, since 1936 principal meteorologist of the U.S. Weather Bureau, on December 21, aged sixty-nine.

NEWS and VIEWS

Prof. W. H. Pearsall, F.R.S.

PROF. W. H. PEARSALL, who has held the chair of botany at the University of Sheffield since 1938, has accepted an invitation from the University of London to become Quain professor of botany at University College, London, from October next. Prof. Pearsall is a graduate of the University of Manchester. After serving in France in the War of 1914–18, he became lecturer and afterwards reader in botany at the University of Leeds, where he founded his reputation in research and teaching. His researches cover a wide range in the fields of ecology and plant physiology, but it is for his contributions to plant ecology that he is best known. He was the first in Great Britain to make a comprehensive study of the vegetation of lakes and to work out the essential relationship which exists between the type of aquatic community and the nature of the substratum. This led to the recognition and the elucidation of the relationship which also exists between the distribution and periodicity of the plankton algæ and the character of the dissolved substances present in lake waters. His work on these problems and others connected with the plant communities of woodland, moorland and bog considered in relation to soil chemistry has given inspiration to many plant ecologists. His contributions to plant physiology include numerous papers on growth and nitrogen metabolism.

Prof. Pearsall acted as joint secretary of the Society for Experimental Biology for many years, he became editor of the *Journal of Ecology* in 1938 and was elected a fellow of the Royal Society in 1940. He played a leading part in the establishment and progress of the Freshwater Biological Association of the British Empire, and for many years conducted postgraduate vacation courses at the Association's laboratories at Wray Castle, Windermere.

New British Agricultural Attaché at Washington and Agricultural Adviser at Ottawa

PROF. JAMES A. SCOTT WATSON, Sibthorpian professor of rural economy in the University of London, who for the past two years has been agricultural attaché on the staff of His Majesty's Ambassador to the United States of America and agricultural adviser to the High Commissioner for the United Kingdom in Canada, will shortly be returning to Great Britain and he will be succeeded by Prof. Robert Rae, professor of agriculture in the University of Reading. Prof. Rae was trained at the University of Edinburgh and the Edinburgh and East of Scotland College of Agriculture. After a short period as lecturer in agriculture at the East Anglian Institute of Agriculture at Chelmsford, in 1921 he became vice-principal of the Hertfordshire Institute of Agriculture, St. Albans. In 1925, he left St. Albans for Northern Ireland, where he was appointed professor of crop and animal husbandry at the Queen's University, Belfast, director of the Agricultural Research Institute of Northern Ireland and head of the Crop and Animal Husbandry Research Division of the Ministry of Agriculture for Northern Ireland. In 1933 he became professor of agriculture at the University of Reading.

Prof. Rae has had wide experience of agriculture under both peace and war conditions. He is a member of various committees of the Berkshire War Agricultural Executive Committee, and serves on the board of the National Institute for Research in Dairying and on the Committee of the Reading Artificial Insemination Centre. He is also a member of the executive committee of the Land Settlement Association. Prof. Rae will be no stranger to the United States, for in 1943 he visited America at the invitation of the United States Department of Agriculture. He travelled widely, visiting agricultural colleges and farming conferences and speaking on British agriculture in war-time, and giving particular attention to the American system of agricultural education.

Dr. G. O. Curme: Willard Gibbs Medallist

DR. GEORGE O. CURME, JUN., vice-president and director of research of the Carbide and Carbon Chemicals Corporation, New York, has been awarded the Willard Gibbs Medal of the Chicago Section of the American Chemical Society for 1944. The award, one of the highest distinctions in American chemistry, is bestowed annually in recognition of eminent work in, and original contributions to, pure or applied chemistry. Dr. Curme has been responsible for the development of the Carbide and Carbon Chemicals Corporation and for its outstanding advances in the field of aliphatic chemistry. Dr. Curme was born in Mount Vernon, Iowa, on September 24, 1888. He received the B.S. degree from Northwestern University in 1909 and the Ph.D. from the University of Chicago in 1913. He continued his graduate studies in Berlin, and during 1914–20 he was a fellow at the Mellon Institute for Industrial Research, Pittsburgh. He became chief chemist of the Carbide and Carbon Chemicals Corporation in 1920, and since 1927 has been vice-president and director of research. He received the Chandler Medal in 1933, the Perkin Medal in 1935, and the Elliott Cresson Medal in 1936.

Prof. E. Pavlovsky

PROF. EVGENI PAVLOVSKY, of the Academy of Sciences of the U.S.S.R. and lieutenant-general of the Soviet Medical Service, has been awarded the Order of Lenin on the occasion of his sixtieth birthday, and in recognition of his scientific work in the field of parasitology. Since 1929 Prof. Pavlovsky has occupied the chair of zoology and comparative anatomy at the Military Medical Academy of the U.S.S.R., and has taken part in expeditions to Central Asia, the Caucasus, Crimea, Trans-Baikal, Iran and Iraq. Several years ago, settlers in the virgin forest districts of the Siberian Taiga caught an unknown disease affecting the tissues of the cerebrum and nervous system; mortality was 25 per cent, and survivors were incapacitated. After persistent work in the Taiga, Pavlovsky discovered the causative agent and elaborated methods of combating it. For this work he was awarded a Stalin Prize in 1939. Pavlovsky has also carried out extensive work in combating typhoid and malaria. He has led a number of expeditions charged with the task of improving health conditions in newly developed agricultural territory and on industrial construction sites in new areas. For many years he has headed the Department of Parasitology of the All-Union Institute of Experimental Medicine. During the War Pavlovsky has done a great deal of work on infectious diseases of the Central Asiatic Soviet Republics and neighbouring countries.

Penicillin Committee

SIR ANDREW DUNCAN, Minister of Supply, has announced that Sir Henry Dale, president of the Royal Society, has been appointed chairman of the Penicillin Committee. The Committee is constituted as follows: Mr. Arthur Mortimer, deputy director of medical supplies, Ministry of Supply (vice-chairman); Dr. V. D. Allison, Ministry of Health; Lieut.-Colonel H. J. Bensted, Army Medical Department, War Office; Prof. R. V. Christie, Medical Research Council, director of the Medical Professorial Unit at St. Bartholomew's Hospital, London; Dr. A. N. Drury, Medical Research Council, director of the Lister Institute; Prof. A. Fleming, professor of bacteriology in the University of London (St. Mary's Hospital Medical School); Prof. H. W. Florey, professor of pathology in the University of Oxford; Dr. C. R. Harington, secretary of the Medical Research Council; Prof. I. M. Heilbron, professor of organic chemistry in the Imperial College of Science and Technology and scientific adviser to the Minister of Production; Prof. R. P. Linstead, deputy director of scientific research, Ministry of Supply, professor of organic chemistry, Harvard University; Prof. H. Raistrick, professor of biochemistry in the University of London; Sir Robert Robinson, Waynflete professor of chemistry in the University of Oxford; Sir Russell Wilkinson, military medical adviser, Ministry of Supply; and representatives of firms engaged in the production of penicillin.

Intelligence and Season of Conception

IT is beyond reasonable doubt, according to Dr. J. Fraser Roberts (*Brit. Med. J.*, March 4, 1944, p. 320), that children conceived in winter are, on the average, somewhat more intelligent than those conceived in the summer; but this fact has been almost universally misinterpreted. Practically every hypothesis brought forward to explain it has depended on the assumption that it is the season of conception that influences the intelligence of the child. Some have even urged the benefits of planned winter conception (for example, Mills, C. A., *Human Biology*, 13, 378; 1941). Dr. Fraser Roberts has tackled the problem by comparing winter and summer children born to the same parents, arguing that, if the season of conception influences the intelligence of the child, the usual difference will be found in such groups; if, however, the real explanation of the observed difference is the fact that the intelligence of the parents influences the season of conception, the two groups will show no difference. A second line of inquiry was the determination of the number of sibs of comparable groups of winter and summer children. Admitting that the evidence that he has gained is not based on very large numbers, Dr. Fraser Roberts concludes that the rather greater intelligence of the child conceived in winter is not due to seasonal influences on the mother or on the developing child; but to the tendency for the more intelligent parents to conceive children rather more often in the winter, while the less intelligent people tend to conceive children rather more often in the summer.

Sunflowers as an Oil Seed Crop

IN the February issue of *Agriculture* there is an account of the progress made during the last four years on the development under English conditions of the sunflower as an oil seed crop, which was also referred to by Mr. E. F. Hurt in a lecture to the Royal Horticultural Society (NATURE, February 26, p. 248). This work, started in 1940 at the Imperial College of Science and Technology by Mr. G. E. Blackman, has since been continued by him and a research team under grants from the Ministry of Agriculture and the Agricultural Research Council. To date it has been found that only semi-dwarf varieties, capable of ripening seed in August or early September, are suitable to Great Britain, for the giant varieties, which mature in the autumn, are very prone to attack from Botrytis. Besides the selection of three varieties—'Pole Star', 'Southern Cross' and 'Mars'—the course of the investigations has demonstrated the primary importance of spacing in controlling maximal yield and the relative small part played by soil type or manuring. By close spacing, yields much in excess of the average in other sunflower producing countries have been obtained, while the seeds are not inferior in the quantity and quality of the oil and protein. In addition, methods of harvesting and threshing suitable for English conditions have been devised. In 1943, the crop was first grown on a field scale on some twenty farms and this year the developmental work is to be expanded. The outlook for sunflowers as a new crop in England appears of distinct promise.

Vacation Work Scheme of the Imperial College

THE Imperial College Union in its ninth annual report of its vacation work scheme shows an interesting record of development for the past year. Under this scheme, students of the Imperial College of Science and Technology are placed, during their vacations, in works and laboratories of industrial firms and of research institutions. During 1943, nearly 500 students registered for this purpose as compared with 180 in 1941, and 226 firms co-operated in this enterprise as against 124, so rapid has been the growth in popularity of the scheme. One of the most significant and welcome features is the extent to which firms have willingly co-operated in securing to the students entrusted to their care, the best possible and the most varied training and experience during their time at these institutions. In many cases a survey of the organization and administration is provided by lectures and tours conducted by members of the staff, in addition to the opportunity to take part in the productive processes in factory, workshop or laboratory. In this way the vacation work scheme at the Imperial College would appear to add to the theoretical studies of the students, whatever their branch of science or engineering, a valuable insight into the structure of industry, and enables them to see at first hand how wealth in the true sense is created from the organized skill and experience of all grades of workers, and how the various branches of science contribute in practice to this end.

In December 1943, the vacation work committee convened a highly successful conference of representatives from a number of the co-operating firms, at which a searching analysis was made by many speakers of various aspects of this scheme. From this it was evident how conscious were these institutions and firms of the part they have to play, jointly with the universities and technical colleges, in the creation of a highly trained body of scientific and technical workers. The scheme is under the chairmanship of Prof. H. Levy, who represents the governing body of the Imperial College; the secretary of the vacation work committee is Mr. J. Newby.

Evolution and Entropy

FOR an essay on "Evolution and Entropy" Mr. E. H. Betts has been awarded the Langhorne Orchard Prize of the Victoria Institute. The main thesis propounded is, that since in the author's opinion 'evolution' is contradicted by the law of entropy and the latter is beyond all question true, then 'evolution' is false or presumably has not taken place. The argument is put forward in a plausible manner and the essay makes interesting reading. What the author understands or means by 'evolution' is not at all clear, and sometimes he uses the word in the sense of change from simple to complex, sometimes it appears to have a moral, ethical or even religious meaning, and sometimes it is a striving towards perfection, whatever that may be. It is a relatively simple matter to endorse any of these points of view by quotations from some author or other, and then reduce to an absurdity or contradiction deductions that can be made from such quotations. Stress is laid on the difficulty of giving a logical statement of the derivation of living from non-living matter, but it seems equally clear that the law of entropy postulates the existence of matter capable of physical measurement but throws no light upon the origin of the matter itself. The ordinary mind has difficulty in imagining, let alone comprehending, that originally there was nothing, and then suddenly there was something ; or the other alternative, that matter has always existed.

Mr. Betts suggests that in Nature and history the direction of progress is from complex to simple ; presumably the organization of our society to-day is more simple than that of the ancient Britons. No biologist familiar with fossil faunas and floras would agree that this is true of the geological records of animals and plants. But perhaps all is well, for the author himself uses the sentence "Evolution itself thus rapidly evolved", and so employs a word which is extremely convenient to express the general idea that, in non-living as in living things, with the passage of time, a change or progression, so long as this is not intended to mean a movement limited to one direction, is, in fact, observable.

Differential Fertility in Canada

CANADA with its many wide spaces and farm lands has tended in the last few years to become more industrialized. It contains a large population of emigrants or the immediate descendants of emigrants from parts of Europe where tradition has influenced the reproductive tendencies of the people. For the future of Canada, which is under-populated, it is of some concern to understand the fertility of different groups of the population in order to supply information for policy-framing. Enid Charles (*Canad. J. Econ. and Pol. Sci.*, **9**, 175 ; 1943) presents an analysis of the differential fertility as seen in the 1931 census. The highest fertility is seen in Quebec and New Brunswick, the lowest in Ontario and British Columbia. There is high fertility among farmers, fishermen and food operatives, and low fertility among textile operatives, loggers, personal service workers, salesmen, owners and managers of manufacturing concerns. The late marriage of office workers and loggers could account for their low replacement birth-rate, while the small size of families of owners and managers accounts for the low fertility of these classes. Provincial differences contribute equally with occupational differences to fertility differences, while origin and religion of the individual are contributing causes. It is important to note that British Columbia, with a comparatively small population, is in reality urban in type—it has a high plane of living, a large majority of Protestants. The fertility is low. In a developing country like Canada, it should be possible to frame the policy and development of the country to enc urage higher birth-rates in those sections of the community which are reduced, but it would seem that the Canadian population may tend to repeat the faults of several European countries unless a check is made by constructional legislation.

Nature of the Viruses

PROF. B. F. OSORIO TAFALL, National School of Biological Sciences, I. P. N., Mexico, has an article with the title "Naturaleza De Los Virus", in *Ciencia* of August 1943, which gives a very useful survey of the work done on viruses. While there is nothing added to our knowledge of the subject by this contribution, it provides an excellent historical review, and as it is written in a popular form, it will prove acceptable to many readers. Among the methods of studying viruses are ultra filters, colour tests (used to investigate psittacosis), photomicrography by ultra-violet light, the electron microscope, etc. New laboratory methods for diagnosing certain diseases caused by a virus which attacks both man and animals have been developed recently. Thus, Hertz described in 1942 how the allantois of the embryo of a chicken, when inoculated with the virus *A* and *B* of influenza, possesses the power of agglutinating the hæmatin, and this provides a simple test for detecting the virus of influenza in the throat and for determining the antibodies existing in the serum of the patient. The subject will be continued in a later issue of *Ciencia*.

The Colômbian Hypericum

AN article under the title "Algunos Chites Nuevos Colombianos" appearing in *Ciencia* of August 1943 (published in Mexico) deals with the Colombian *chite*, a plant belonging to the genus Hypericum. This genus comprises about three hundred known species which are distributed in the subtropical regions, being scarce in the temperate zones. Colombia has many forms of the plant and up to the present twenty-five species have been found in the country. The author of the article, Jose Cuatrecasas, Escuela Superior de Agricultura Tropical, Cali, Colombia, acknowledges his indebtedness to Dr. Prittier, through whose kindness he has been enabled to study *H. caracasanum*. As a result of his investigations a number of previous identifications have been altered, and changes made regarding certain species and new varieties. Short descriptions are given of *H. ruscoides*, *H. magniflorum*, *H. stenoclados*, *H. tamanum* and *H. lancioides*.

Earthquakes Registered in New Zealand and Spain

DURING November 1943, seven strong earthquakes were registered by the seismographs at the New Zealand observatories. These were on November 2, 4, 6 (two), 13, 26 and 28. The shock of November 26, with an epicentral distance from Wellington of about 83°, had a focal depth estimated between 130 km. and 140 km. In addition, nineteen earthquakes were felt in some part of New Zealand. The strongest three of these had intensity VI and were felt (1) on November 5 from Greymouth to Arthur's Pass, (2) on

November 5 later in the day in the southern parts of North Island, and (3) on November 24 in the south-west parts of South Island.

In Spain during the same month, twenty-five earthquakes were registered by the seismographs at the Geophysical Observatory at Toledo. The earthquake of November 11, registered at 22h. 57m. 51s. G.M.T., had an estimated epicentral distance from Toledo of 370 km. and a focal depth of 25 km. Its epicentre is likely to have been in the neighbourhood of lat. 37·4° N., long. 1·7° W., which is just west of the town of Aquilas on the Mediterranean coast of Spain. The earthquake was felt at Granada with intensity V.

Study of Physical Medicine

According to the *Journal of the American Medical Association* of December 25, the first centre for the scientific study and development of physical medicine as a branch of medical practice has been established by the National Foundation for Infantile Paralysis in the Graduate School of Medicine of the University of Pennsylvania. The centre will include a department for development of physical medicine as a scientific part of the practice of medicine, a training centre for medical leaders and teachers in this branch of medicine, and a school for training technical workers. The departments of anatomy, physiology pathology and other basic sciences of the University of Pennsylvania will co-operate in this proposed programme.

The Chronica Botanica Co.

The Chronica Botanica Co., of Waltham, Mass., has issued a special edition of Dr. C. A. Browne's "Thomas Jefferson and the Scientific Trends of his Time" (an advance reprint from *Chronica Botanica*, 8) on the occasion of the tenth anniversary of its establishment. The Chronica Botanica Co. was founded in Leyden, the Netherlands, in September 1933, and was transferred to the United States early in 1940. An old, interesting, symbolic engraving, reproduced on an insert with the commemorative booklet, recalls the successful transfer of the firm's entire stock and its unique collection of source material in the history of botany and horticulture, just a few months before the invasion of the Low Countries. The firm, which is directed by Dr. Frans Verdoorn, publishes *Chronica Botanica*, "A New Series of Plant Science Books" and *Annales Cryptogamici et Phytopathologici* (formerly *Annales Bryologici*). Special projects in the course of preparation include: "Plants and Plant Science in Latin America" and the "Index Botanicorum".

American Academy of Arts and Sciences Grants

Income from the Permanent Science Fund of the American Academy of Arts and Sciences is used to support scientific research in the fields of mathematics, physics, chemistry, astronomy, geology, geography, zoology, botany, anthropology, psychology, sociology and economics, history and philology, engineering, medicine, surgery, agriculture, manufacture and commerce, education, or any other science of any nature or description. Equipment purchased outright through a grant from the Fund is subject to reassignment by the committee of award, upon termination of research in the particular field of endeavour in support of which a grant is made. Grants are not made for the financial support of work the results of which comprise partial fulfilment of requirements for an academic degree. It is a policy of the committee of award not to approve requests for general permanent equipment for institutions. Applications for grants-in-aid should be made on forms to be obtained from the chairman of the committee, and will be considered on June 1 and October 1. Communications should be addressed to John W. M. Bunker (chairman), Permanent Science Fund Committee, Massachusetts Institute of Technology, Cambridge 39, Massachusetts.

Announcements

The Executive Council of the Imperial Agricultural Bureaux has elected Mr. G. H. Creasy (Colonial Empire) as chairman in succession to Mr. Shamaldhari Lall (India). Lieut.-Colonel J. G. Robertson, representative on the Council of the Dominion of Canada, was elected vice-chairman.

The Colonial Office announces that Dr. E. E. Williams, of Trinidad, has been appointed secretary of the Agricultural Committee of the Caribbean Research Council. Dr. Williams, who has been assistant professor of social and political science at Howard University, Washington, has made a special study of economic problems in the British West Indies. He was born in 1911, and graduated at the University of Oxford.

The Secretary of State for the Colonies has decided, after consultation with the Governors of Northern Rhodesia and Nyasaland, to appoint a joint development adviser for the two territories, and Mr. G. F. Clay, director of agriculture in Uganda, has been appointed to the post. Mr. Clay has recently served as director of supplies for Uganda and director of native production for East Africa.

Many have been wondering how the gypsies have fared during the European War. After all, less than most folk are they concerned with the social and economic causes which have given rise to the present conflagration. The present issue of the *Journal of the Gypsy Lore Society* (**23**, pts. 1–2) contains the life and travels of Peter Lazarovič the Rudar, a vivid account of the story of an old gypsy who has had a chequered existence. There is also an interesting study of Esther Young, an English gypsy witch.

The annual report of the Board of Regents of the Smithsonian Institution for the year ended June 30, 1941, which has already been noted in Nature (**149**, 326; 1942), has now been issued as a bound volume (Washington, D.C.: Gov. Printing Office. 2 dollars) containing in a general appendix the customary miscellaneous selection of papers, some of them original, covering a wide range of scientific investigation and discussion. This appendix runs to some 450 pages. Among the papers not previously published elsewhere are those by E. P. Walker on "Care of Captive Animals"; F. C. Craighead on "The Influence of Insects on the Development of Forest Production and Forest Management", and F. C. Chase on "Useful Algæ". A number of others, such as those of H. C. Hottel on "Artificial Converters of Solar Energy"; J. W. Lasley, jun., on "Mathematics and the Sciences"; H. E. Munsell on "Vitamins and their Occurrence in Foods"; and W. N. Fenton on "Contacts between Iroquois Herbalism and Colonial Medicine", are now made more accessible to scientific workers.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Ascorbic Acid and Hip Fertility in Rosa Species

FOR the past few years we have been studying the genetical and other problems presented by a rose population growing on a pit heap in Co. Durham. Only two species, *Rosa mollis* var. *typica* and *R. dumetorum* var. *ramealis*, are involved; but, in addition, there is a unique hybrid between the two which, as it possesses a chromosome complement of thirty-five, has the parentage *dumetorum* ♀ × *mollis* ♂.

Among the points investigated were the ascorbic acid contents of the three forms. These worked out at 1,420 mgm. of ascorbic acid per 100 gm. of flesh in the case of *R. mollis*, 724 mgm. for *R. dumetorum* and 941 mgm. for *R. dumetorum* × *R. mollis*. Such results instantly raise doubts respecting the correlation which Gustafsson and Schröderheim[1] seek to establish between low hip fertility and amount of ascorbic acid.

Although the average height of the individuals composing the *R. mollis* colony is just below 1 m., and that of the *R. dumetorum* forms a little more than 1·5 m., owing to the influence of heterosis, our hybrid attains a height of 4 m. and sprawls over a very considerable area. Nevertheless, its fertility is extremely low; of the four thousand flowers it was estimated to carry in June 1942, the bulk fell at once when the fruit began to develop in July. In the end, only twenty-eight ripe hips were displayed in September and October. Of these, nine contained no mature achenes, eight had one each, eight had two, two had three and one had six—an average of 1·28 per hip. If these results are compared with an average of thirty-one achenes per hip observed in the *R. mollis* colony, and twenty-nine per fruit in the *R. dumetorum* group, a full appreciation of the general sterility of the hybrid and of its low hip fertility will be gained. Further, when the ascorbic acid contents of the three forms are set alongside these figures, it will be obvious that our findings afford no confirmation of Gustafsson and Schröderheim's attempted negative correlation between hip fertility and ascorbic acid content.

In our opinion the results are simply a matter of heredity. Nor do we consider that Table 1, as put forward by Gustafsson and Schröderheim, supplies weighty evidence opposed to that view. In the first place, it should be emphasized that, owing to the marked difference in chromosome complements in the male and female gametes in the Canine roses, reciprocal hybrids in which they are concerned are not only quite dissimilar, but also are capable of manifesting certain characters in an exaggerated fashion. Moreover, it should be noted that Gustafsson and Schröderheim state definitely that their hybrid between "*R. canina*" and *R. rubiginosa* showing the less ascorbic acid value ripens later—a fact known to be correlated, independently of any hip sterility or fertility, with a lower content of vitamin C.

Again, we should like to urge that "Cases 1 and 2", considered by Gustafsson and Schröderheim and summarized in Table 2, are vitiated as evidence by facts not immediately apparent to British workers. Their "*Rosa canina*" includes four series regarded as species by British rhodologists: these are *R. canina*, *R. dumetorum*, *R. dumalis* (*Afzeliana*) and *R. coriifolia*, the former pair characterized by biotypes with low ascorbic acid values, and the latter pair by biotypes containing relatively high amounts. We cannot conceive how material so genetically heterogeneous, and so diverse in its ascorbic acid heredity, can be assembled promiscuously for mathematical treatment in such a way as to yield figures of real significance.

Lastly, it is asserted that, for a full ripening of a rose receptacle, only one or two fruits are required, which seems to imply that at least one must be present. In our experience, such development will occur in the absence of seeds. At present, we have under observation an example of the hybrid *R. Sherardi* ♀ × *R. spinosissima* ♂, which flowers freely but fruits sparingly; on the average, no fewer than 55 per cent of its hips, usually well developed, contain no mature achenes, and such cases could be extended materially.

J. W. HESLOP HARRISON.
G. A. D. JACKSON.

King's College,
Newcastle upon Tyne, 2.
Feb. 21.

[1] NATURE, 153, 196 (1944).

IN the course of an investigation of rose hips as a source of vitamin C, undertaken with Dr. Magnus Pyke[1], no marked correlation was observed between the ascorbic acid content of the hip flesh and the percentage weight of achenes (nutlets or pips) in the hips. The publication by Gustafsson and Schröderheim[2] of their hypothesis that vitamin C content is negatively correlated with hip fertility has induced me to re-examine the earlier data together with some obtained later.

The range and the mean of both vitamin content and pip content differ from species to species. Thus, in *Rosa canina* a mean vitamin C content of 493 mgm. per 100 gm. of hip flesh and a mean pip content of 39 per cent was found, while in *R. Afzeliana* the figures were 1,121 mgm. and 36 per cent respectively. The effect of mixing data from two such species, as do Gustafsson and Schröderheim in their Case 1, would be to produce a false negative correlation between vitamin content and pip content. It is therefore important to consider the data for each species separately.

Our most extensive series of observations concerned *R. canina* and are summarized in the accompanying table. Contrary to the suggested correlation, low vitamin contents are found associated with both the highest and the lowest ranges of pip content, although the highest vitamin value, 1055, is for a sample with a relatively low pip content, 31. The mean vitamin contents are not significantly different from one another, or from the species mean, over the central ranges of pip content which include the bulk of the observations. A very low negative correlation ($r = -0{\cdot}10$) was calculated from these data, and this was not significant ($P = 0{\cdot}4$–$0{\cdot}3$). Data for other species are equally unfavourable to the hypothesis.

If the suggested negative correlation exists, one might expect differences in the vitamin content of hips from individual bushes from year to year, according to the number of achenes matured. The figures for *R. canina* and *R. rubiginosa* given by Gustafsson and Schröderheim are contrary to this theory. Our own observations of this kind are

Range of ascorbic acid and pip contents in hips of *Rosa canina*

Weight of pips (per cent)	No. of observations	Mean vitamin C (mgm./100 gm.)	Range of vitamin C (mgm./100 gm.)
20–24	1	187	187
25–29	2	275	100–450
30–34	13	546	205–1055
35–39	28	501	115–850
40–44	23	508	164–1010
45–49	8	509	370–735
50–54	2	498	385–610
55–59	2	172	120–224
Total	79		

Species means Vitamin C content, 493 Percentage of pips, 39.

limited but generally unfavourable. Thus hips of a bush of *R. canina* var. *dumalis* assayed in 1941 had 44 per cent pips and 164 mgm./100 gm. vitamin C; but in 1942, 29 per cent pips and only 100 mgm./100 gm. Corresponding figures for a bush of *R. mollis* were 1941 : 24, 1,490 ; 1942 : 15, 1,653 ; 1943 : 23, 1,650; and for a bush of *R. dumetorum*, 1941 : 51, 920 ; 1942 : 32, 935 ; 1943 : 33, 960. More numerous data published earlier by Schröderheim[3] on *R. pendulina* (Tables 9–12) and *R. rugosa* (Tables 33–34) appear to be no more conclusive.

It is noteworthy that of the three 'cases' cited by Gustafsson and Schröderheim, the correlation is lowest and least significant for the single species *R. rubiginosa*. The correlation is a little higher and significant for the mixture (Case 1) consisting mainly of *R. canina* and *R. Afzeliana*, and the only high correlation is for a heterogeneous mixture (Case 2). Probably this progression is due to an increased mingling of species having high vitamin and low pip content with others possessing low vitamin and high pip content. Among British roses the specific differences tend in these directions and appear to be due to hereditary differences in vitamin production coupled with differences in the proportions of the receptacle, and are independent of fertility. The diversity of vitamin content and fertility between the reciprocal hybrids of *R. canina* and *R. rubiginosa*, observed by Gustafsson and Schröderheim, can be regarded as another example of a kind of variation not uncommon among hybrids and genetical in origin.

Ronald Melville.

Royal Botanic Gardens,
Kew.

[1] Pyke, M., and Melville, R., *Biochem. J.*, **36**, 336 (1942).
[2] Gustafsson, A., and Schroderheim, J., Nature, **153**, 196 (1944).
[3] Schröderheim, J., *Kungl. Fys. Sällsk. Handl.*, **52**, No. 9 (Lund, 1941).

Preparation of Retinene *in Vitro*

Retinene, obtained by Wald from dark-adapted retinas, is defined as the chromogen responsible for a maximum at 664 mμ in the absorption spectrum of the blue solution obtained by mixing retinal extracts with antimony trichloride in chloroform. Such extracts show (in chloroform) an ultra-violet absorption band with $\lambda_{max.}$385 mμ. It has recently been suggested[1] that the chromogen is vitamin A aldehyde, and that it can be obtained by direct oxidation of vitamin A alcohol.

The following procedure yields small quantities of retinene in a state approaching purity. 2 gm. of distilled vitamin A alcohol ($E^{1\%}_{1cm.}$ 325 mμ 800, *c.* 46 per cent vitamin A) is dissolved in 40°–60° petrol ether (50 c.c.) and the solution poured into 5 per cent sulphuric acid (400 c.c.) at 25° C. *N*/10 potassium permanganate (600 c.c.) at 25° C. is then run in rapidly with vigorous shaking for a few minutes. The mixture is allowed to settle in a separating funnel and the aqueous layer discarded. The petrol ether layer is washed twice with water and dried over sodium sulphate. It is then poured on to a column of alumina (Brockmann) and the chromatogram developed with petrol ether. The solute is gradually washed through the column and the fractions are tested separately (1 or 2 drops with 4 c.c. antimony trichloride reagent). If each successive 10 c.c. portion of eluate is regarded as a 'fraction', the results can be summarized as in the accompanying table.

Fractions containing the 664 mμ chromogen only show

$$E^{1\%}_{1cm} \quad \begin{array}{ll} 664\ m\mu & >3200 \\ 361\ m\mu & 1420\ (petrol) \\ 385\ m\mu & 1570\ (chloroform) \end{array}$$

while the best fractions for the 560 mμ chromogen show

$$E^{1\%}_{1cm.} \quad 560\ m\mu/355\ m\mu \;=\; 2:1.$$

For both substances, the molecular extinction coefficient for the ultra-violet maximum approaches that of vitamin A. The 664 mμ chromogen is undoubtedly retinene. It is by no means an unstable substance. In cyclohexane, the ultra-violet maximum falls near 368 mμ and in petrol nearer 361 mμ. The 560 mμ chromogen (the nature of which cannot yet be discussed) is also a stable substance exhibiting a similar displacement of the ultra-violet maximum from 355 mμ in chloroform to 342 mμ in petrol. Hunter and Hawkins[2], in recording the preparation of vitamin A aldehyde by the Oppenauer method, give $\lambda_{max.}$657 mμ in the colour test and two maxima (368 and 350 mμ) for the ultra-violet absorption in cyclohexane. Wald at first gave 655 mμ for the colour test maximum, but later corrected it to 664 mμ. His ultra-violet maximum at 385 mμ refers only to chloroform solutions. The large solvent displacement, 368–385 mμ, which we have observed reconciles the data and makes it clear that retinene and vitamin A aldehyde are spectroscopically indistinguishable. We have not so far found the 664 mμ and 560 mμ chromogens to be

Fractions	Approx. conc. (per cent)	$\lambda_{max.}$ in $SbCl_3$ colour test (mμ)					$\lambda_{max.}$ ultra-violet absorp. in chloroform; in petrol (mμ)				
		620	610, 583	664	560	490	325; 325	355; 342	385; 361	332; 321	300; 287
1–10		+					+				
11–13					+	++		+			++
24–26					++			++			
27–41	0·06			+	+++			+++	+		
42–50	0·02			++	+			+	++		
51–57	0·018			+++					+++		
58–66	0·025			+					+		
67–70	0·045		+							+	+

interconvertible, and the best fractions of the former show one ultra-violet maximum only.

The elegance and accuracy of Wald's work on retinal extracts makes us hesitate to suggest that the term *retinene* is inappropriate. Unfortunately, it suggests a retinal carotenoid. *Axerophthal*, following Karrer's terminology, is not very happy in this context. Perhaps *retinaldehyde* is more appropriate than retin*al*.

A fuller account of this work will be published elsewhere. We express our thanks to the Medical Research Council for financial assistance.

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[2] Hunter and Hawkins, NATURE, 153, 194 (1944).

Molecular Weight of Egg Albumin

THE molecular weight of egg albumin quoted in all but the most recent literature is 35,000–36,000, a value based on the early osmotic pressure measurements of Sørensen[1], the ultracentrifuge measurements of Svedberg and Nicols[2], Nicols[3], and Sjögren and Svedberg[4], as well as the diffusion data of McBain[5]. More recently, however, there has been general agreement that this value is too low; the sedimentation constant and diffusion data quoted by Svedberg and Pedersen[6], for example, as well as the osmotic pressure data summarized in Table 1, indicating a value of 43,000–46,000.

TABLE 1.

Author	Solvent used	Result
Sørensen	Water	34,000[1]
Adair (recalculated Sørensen's data)	Ammonium sulphate	43,000[7]
Marrack and Hewitt	Sodium acetate and sodium chloride	43,000[8]
Taylor, Adair and Adair	Sodium acetate	46,000[9]
Bull	Sodium acetate	45,160[10]

I have had occasion, while rehearsing the procedure to be applied to certain other proteins, to make osmotic pressure measurements with solutions of egg albumin. This protein was prepared by Prof. R. K. Cannan using the method of Kekwick and Cannan[11], and the amount in solution was estimated by the micro-Kjeldahl procedure and nitrogen figures of Chibnall *et al.*[12]. McIlwain's phosphate-citric acid buffer at pH 4·65 was used as solvent.

The osmometer used was of the type described by Adair[13], but the collodion membranes contained about 3 c.c. instead of 20 c.c. of protein solution. Pressures were calculated from the height of the column of solution of known density, corrected for the rise due to capillarity.

TABLE 2.

C_p	Pressure	Molecular weight
1·00	3·92	43,400
1·86	6·71	47,200
4·00	14·4	47,300
4·23	16·7	43,100
5·84	21·1	47,200
5·95	22·0	46,000
6·26	22·2	48,100
6·88	26·1	44,900
8·30	30·6	46,200
8·84	32·5	46,300
	Average	45,970

The computed values for the molecular weight are given in Table 2, where the pressures are recorded in millimetres of mercury at 0° C. It was found that over the range investigated the osmotic pressure was directly proportional to the protein concentration C_p, expressed in gm. per 100 c.c. solvent. The calculated results for the molecular weight, which are in agreement with those recorded in Table 1, though obtained under different conditions, show that the value is almost certainly 45,000 ± 2,000.

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Number of Configurations of Molecules occupying Several Sites

IN a recent communication[1], I gave a formula for $g(N_i)$ the total number of configurations of a mixture of molecules of several types, N_i denoting the number of type i. I have meanwhile obtained the more general formula for $g(N_i,X_{ij})$, the number of configurations of the molecules in which the number of pairs of sites occupied in alternate ways is specified.

Let the number of sites which are neighbours of one site be z; let each molecule of type i occupy r_i sites; let the number of sites which are neighbours of a molecule of type i be q_iz. The r_i's and q_i's are related by $z(r_i - q_i) = 2(r_i - 1)$. Let the number of alternative configurations of a molecule of type i be ρ_i when a site has been chosen for one of its elements. Let the number of pairs of neighbouring sites, one occupied by a molecule of type i the other by a molecule of different type j, be denoted by zX_{ij}.

The number $g(N_i, X_{ij})$ of distinguishable configurations of given N_i and X_{ij} is given by

$$\log g(N_i,X_{ij}) = \Sigma_i N_i \log \rho_i - \Sigma_i \log N_i\,! + z\Sigma_i \log (q_iN_i)\,! - (\tfrac{1}{2}z - 1) \log (\Sigma_i r_i N_i)\,! - \tfrac{1}{2}z\, \Sigma_i \log (q_iN_i - \Sigma'_k X_{ik})\,! - z\Sigma'_{ij} \log X_{ij}\,!,$$

where Σ' denotes summation over all types except i. This includes as special case a formula due to Chang[2] for a mixture of two types of molecule, of which one type occupies two sites, the other a single site.

The above formula can be used to derive the thermodynamic properties of mixtures with non-zero energies of mixing, whereas my previous formula was sufficient for mixtures with zero energies of mixing. In particular, I find that T_c, the temperature of critical mixing of a binary mixture of molecules A and B, is related to w, the intermolecular energy per pair of sites one occupied by part of an A the other by part of a B molecule, by the formula

$$e^{2w/kT_c} = \tfrac{1}{2}\{1 + ab + \sqrt{(a^2-1)(b^2-1)}\},$$

where $a = zq_A/(zq_A - 2)$ and $b = zq_B/(zq_B - 2)$.

Full details are being published elsewhere. Some of the formulæ for the case of a binary mixture in which the molecules of one type occupy single sites have already been given by Orr[3].

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A Modification to the Cryoscopic Equation

IT is known that the molecular weights of pure solutes as calculated by the cryoscopic method are not found to be constant for varying dilutions, and it has been reported[1] that K_f also varies, the tendency being for the cryoscopic constant to decrease in value as the concentration increases. Meldrum, Saxer and Jones[2] studied this anomaly in the case of camphor and found that for various solutes of known molecular weights, the constant for one gram-molecule per 1,000 grams of solvent fell from 50 at low concentrations to 39·7 in solutions of molality greater than 0·2.

These observations were confirmed by us not only for camphor but also for benzene, where K_f decreased from 7·20 to 5·35 between molalities 0·075 and 1·0.

The difficulty which arises from variations in both K_f and molecular weights at different concentrations has been overcome by using a modified equation of the form:

$$\Delta t = K_f . m^b \qquad (1)$$

$$\text{or } \log \Delta t = \log K_f + b \log m \qquad (2)$$

The validity of this equation was checked by plotting $\log \Delta t$ versus $\log m$ for different solutes of known molecular weights in the cryoscopic solvents benzene and camphor respectively. For all cases studied, straight lines were obtained similar to the accompanying diagram showing the plot for naphthalene and camphor in benzene.

Applying a summation method to equation 2:

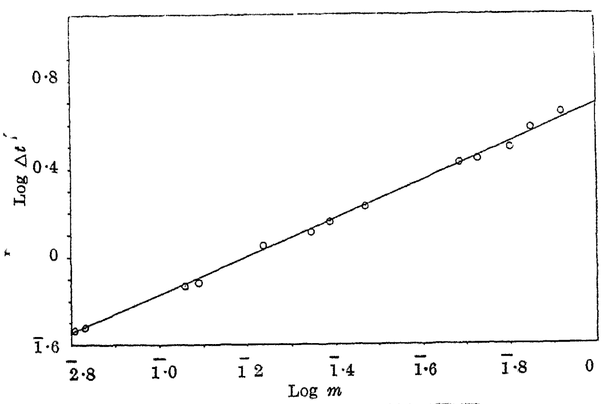
$$\Sigma \log K_f + b \Sigma \log m - \Sigma \log \Delta t = 0$$

$$\log K_f \Sigma \log m + b \Sigma \log^2 m - \Sigma \log \Delta t . \log m = 0,$$

we obtained $K_f = 5{\cdot}14$ and $b = 0{\cdot}8961$.

Hence the modified equation for pure solutes in this sample of benzene was: $\Delta t = 5{\cdot}14\ m^{0{\cdot}8961}$. For the results quoted by Meldrum *et al.* on camphor: $\Delta t = 38{\cdot}73\ m^{0{\cdot}9580}$.

K_f is found by this method to vary for different samples of the cryoscopic solvent. Thus for a different stock of benzene, $K_f = 5{\cdot}229$, whereas b, although constant for all pure solutes in a given sample of solvent, is extremely sensitive to impurities. It should be pointed out that cases may be found in which the value of b is unity and the modified equation consequently becomes identical with the classical.



NAPHTHALENE AND CAMPHOR IN BENZENE.

The accompanying table gives the molecular weights of tetralin in benzene (*a*) using the classical equation, $\Delta t = K_f m$; (*b*) using the modified equation $\Delta t = K_f m^b$.

Concentration (per cent by weight)	Depression (Δt ° C.)	Molecular weight calculated on $\Delta t = 5{\cdot}229\ m$ (classical)	Molecular weight calculated on $\Delta t = 5{\cdot}229\ m^{0{\cdot}9394}$ (modified)
0·68	0·321	111·6	133 2
1·98	0·876	118·0	132·4
3·98	1·636	127·1	137·0
7·94	3·165	131·2	135·5
11·13	4·316	134 9	136 6

It is seen that by applying the classical equation the calculated molecular weight increases and approaches a value in the region of 132–136. Application of the modified equation, however, produces a set of reasonably consistent values, the mean of which is 136·1.

No attempt is made here to explain the anomaly of K_f at different concentrations, but it is suspected that a more rigid application of thermodynamic theory, on which the classical equation is based, is necessary. For the present, the above equation is proposed as one which gives consistent results at all concentrations below 1·0 molality.

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Dissociation Energy of Nitrogen

VAN DER ZIEL[1] has observed weak predissociation in the First Positive system of N_2 for bands with v' greater than 11. The predissociation was reported to be of the type which increases in strength with the rotational quantum number J, and both Λ doubling components of the $B^3\Pi_g$ state are affected. Van der Ziel therefore concluded, apparently with good reason, that the state causing the predissociation was of type Δ. This led to the conclusion that a dissociation limit, the products of which were capable of producing a Δ state, must lie below the energy of the predissociation. Combining this information with the known predissociation limit for the $C^3\Pi_u$ state at 12·145 e.v., this gave a value of 7·383 e.v. for the dissociation energy of nitrogen, a value which has been generally accepted.

Gaydon and Penney[2] have pointed out that if this value is correct, then the rule that potential energy curves of molecular states of the same species may not cross must be violated. They suggested that the dissociation energy was probably about 9 e.v. This is now supported by the discovery that Van der Ziel's interpretation of his predissociation is not a unique solution.

The selection rules for predissociations or perturbations are usually quoted as: (1) Λ, the quantum number of the resultant electronic (orbital) angular momentum about the internuclear axis, may change by ± 1 or 0. In the former case the strength of the predissociation increases with J; in the latter case it is independent of J. (2) The $+\ -$ symmetry is unchanged, that is, $+ \rightarrow +$, $- \rightarrow -$, $+ \nrightarrow -$. For homonuclear molecules the $g\ u$ symmetry is unchanged, that is, $g \rightarrow g$, $u \rightarrow u$, $g \nrightarrow u$. (3) For strong predissociation the spin, S, must not change, but weak predissociation may occur for $\Delta S = \pm 1$. (4) The rotational quantum number remains unchanged, that is, $\Delta J = 0$.

Now for predissociation of a $^1\Pi$ state by $^1\Sigma$, it follows from the $+ \nrightarrow -$ rule that only one of the two components (due to Λ doubling) of the $^1\Pi$ state will be affected. This also appears, experimentally, to be the case for the predissociation of a $^2\Pi$ state, which is in Hund's case b, by a $^2\Sigma$ state, as, for example, in the spectrum[3] of MgH. In this case, however, each J value occurs twice for the $^2\Sigma$ state, once with $+$ symmetry and once with $-$ symmetry, so that with the selection rules as listed above there appears no obvious reason why both Λ components of the $^2\Pi$ state should not be affected. To account for the observed predissociation of one component only, it appears necessary to assume the further restriction $\Delta K = 0$. While not explicitly stated, this rule appears to have been tacitly assumed, and in case b where the rotational energy is determined chiefly by the quantum number K, this seems reasonable.

For nitrogen, however, the $B^3\Pi_g$ state approximates to Hund's case a. In this case the rotational energy is determined by J, and K is no longer a true quantum number. Thus the rule $\Delta J = 0$ may be expected to hold, but not $\Delta K = 0$.

Now the lowest dissociation products for nitrogen are $N(^4S) + N(^4S)$, and these products can, on the Wigner-Witmer correlation rules, lead to a $^5\Sigma_g^+$ state. In this state each rotational level will be split, by spin, into five components, so that each J value occurs five times, thrice with one symmetry (say $+$) and twice with the other symmetry (say $-$). Thus, assuming that for the predissociation of the case a $^3\Pi_g$ state, only the selection rule $\Delta J = 0$ holds, both Λ components of the $B^3\Pi_g$ state may be affected. Thus it appears that Van der Ziel's explanation of the predissociation is not the only one possible, but that it might equally well result from a repulsive $^5\Sigma_g^+$ state arising from normal dissociation products. This latter explanation is preferable, because, by using the higher value for the dissociation energy to which it leads, the non-crossing rule for the potential energy curves can be maintained.

It thus appears that the dissociation energy of nitrogen is 9·764 e.v.

The dissociation energy of nitric oxide is linked thermochemically with that for nitrogen, and the new value for $D(N_2)$ leads to $D(NO) = 6{\cdot}49$ e.v. instead of 5·29 e.v.

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[1] Van der Ziel, A., *Physica*, 4, 373 (1937).
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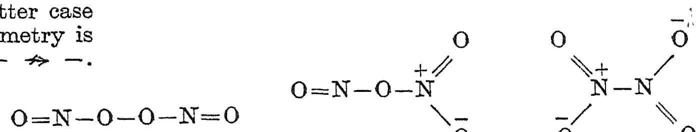
Structure of the Nitrogen Peroxide Molecule

HITHERTO three structures for the nitrogen peroxide (N_2O_4) molecule have received support:



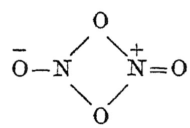
(i) (ii) 2 resonance states (iii) 4 resonance states

Study of the electron-diffraction pattern of nitrogen peroxide gives no conclusive evidence as to the structure[1]. The X-ray diffraction pattern of the powdered solid suggests that the molecule is symmetrical, but gives insufficient parameters to fix the relations of the atoms[2].

Structures i and ii are *a priori* chemically reasonable. However, the vibrational (infra-red and Raman) spectra of N_2O_4 indicate that the molecule is highly symmetrical and non-linear[3,4]. The value of the entropy[5] also supports a more symmetrical structure.

Structure iii predicts satisfactorily the vibrational frequencies of N_2O_4, if it is supposed that the N—N link has the abnormally low force constant $1{\cdot}5 \times 10^5$ dynes/cm. On the basis of this model, the spectroscopic data give a value of the entropy in good agreement with the thermodynamically measured value, but only if it is assumed that there is no free relative rotation of the ends of the molecule about the central link[5]. This structure violates Pauling's adjacent charge rule[6], for which there is much empirical evidence; and it is difficult to reconcile the weakness of the N—N link with its torsional rigidity.

A fourth structure

(iv)  (planar: 2 resonance states)

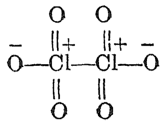
is here proposed. This model has the same symmetry as the planar form of iii, and gives precisely the same numbers of fundamental frequencies in both the Raman and infra-red spectra. Qualitatively, therefore, it gives as good a fit with observation as the planar model iii, which has been shown to account satisfactorily for the vibrational spectra[3], though Harris and King[7] consider that some of the molecules may have the twisted form. The observed fundamentals can be simply interpreted in terms of the valence-force model iv: in particular, the low Raman frequency at 283 cm.$^{-1}$, previously interpreted as the oscillation of a very weak N—N link, is now attributed to an angular deformation of the ring, which would be expected to involve a small energy change compared to that associated with the stretching of a covalent link. Moreover, there is no motion of iv corresponding to internal rotation in iii, so that there is no need to explain, as for the latter, why such a motion makes no contribution to the entropy. Detailed analysis of the vibrational spectra on the basis of iv is now in progress. Further, iv is in accordance with the adjacent charge rule.

Other compounds containing a 4-membered ring of this type are the carbonato- and sulphato-com-

plexes, and the molecule HI_3O_8. Such a ring is probably also present in chloride hexoxide (Cl_2O_6), as might be expected from the formal analogy between the pairs of compounds:

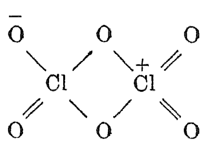
$$\begin{array}{lllll} ClO_2 & ClO_3 \rightleftharpoons Cl_2O_6 & Cl_2O_7 & Cl_2O_8 \\ NO & NO_2 \rightleftharpoons N_2O_4 & N_2O_5 & N_2O_6 \end{array}$$

As usually written:



(ethane-like model, in which each double bond has partial co-ordinate-link character)

the structure of Cl_2O_6 violates the adjacent charge rule. The alternative structure



here proposed is similar to the structure iv above for nitrogen peroxide. There are four possible resonance states, not counting those in which some or all of the double bonds are replaced by co-ordinate links. In the structure shown, the right-hand Cl atom has the same valency state as the Cl in the tetrahedral $[ClO_4^-]$ ion, and the left-hand atom is pentavalent as in the pyramidal $[ClO_3^-]$ ion. Hence the chlorine atoms are probably tetrahedral, in which case chlorine hexoxide is geometrically analogous to the dimeric aluminium halides, and to the derivatives $M_2H_2R_6$ (M = B or Ga, R = H or alkyl) of boron and gallium[8,9]. However, the vibrational spectrum of Cl_2O_6 has not been measured, and there is no other direct experimental evidence yet for either structure.

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Women with Colour-Blind Relatives

AN experiment was carried out on 98 women and 104 men with 'normal' red-green vision, on 4 women and 14 men who had various degrees of red-green blindness, and on 3 men who are green-anomalous because they reject the normal Rayleigh equation by a wide margin. The experiment was along the lines of Collins's research on the Rayleigh equation with rotating disks[1], and the details of the technique and other results will be published later.

The 'normal' women subjects were all asked to give information about any colour-blind relatives so far as they were able, and some of these relatives were among the colour-blind men and women tested. Colour-weak subjects, like the colour-blind, accept a wider range of matches in the Rayleigh equation than do the most sensitive normal subjects. These differences in range were measured by an efficient psycho-physical technique, together with the usual deviations in the Rayleigh equation.

If we pick out those women who pass the Ishihara test with little or no difficulty and therefore are not colour-blind, who accept or almost accept the normal Rayleigh equation and are therefore not anomalous, but who can make *at least twice the modal range of* matches in the Rayleigh equation carried out in this research, then the accompanying table can be constructed. For this table chi-squared is about 20, calculated from the marginal totals, showing that it is extremely unlikely that such differences could have been obtained by chance. The table is strong evidence that women who are blood-relatives of colour-blind subjects, and who, accordingly, must often be potential if not actual mothers of colour-blind sons, have a decided and measurable red-green weakness much more frequently than women in general.

WOMEN WITH 'NORMAL' RED-GREEN VISION.

	Known C-B relative	No known C-B relative
Twice modal range or more	11	7
Less than twice modal range	10	70

I am indebted to Dr. Mary Collins for her advice in setting up the experiment and to Mr. Joseph F. Simpson for frequent help.

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[1] Collins, M., *Brit. J. Psych.*, 19, 4, 387 (April 1929).

Colonial Geological Surveys

IN his article on Colonial Geological Surveys in NATURE of March 4, Mr. V. A. Eyles gave a useful résumé of recent discussions. There are, however, some further considerations to be noted. The figures he quoted from Sir Edmund Teale's paper of the results of mining operations, following upon the activities of Colonial Geological Surveys, do not include any statement of the amount and disposal of mining profits, or of the proportion of such profits set aside for the benefit of the local inhabitants as compensation for the loss of their national wealth. Thus arises the impression in some Colonial circles that Geological Surveys exist mainly for the benefit of outside mining interests—an erroneous impression which leads to friction between Geological Surveys and other Government Departments, administrative, agricultural, educational, etc., more directly engaged in promoting the welfare of the local inhabitants. Some change in Colonial policy after the War seems, therefore, desirable.

It is to be hoped that in the future the rights of ownership of their own mineral wealth by the people of the Colonies will be fully recognized, that the pre-war policy of exploitation of minerals by outside interests will become a matter of history and that the mineral resources of the people will be worked with the approval and for the benefit of the people, either by the people themselves or by the Colonial Governments on their behalf.

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THE research activities in zoology and botany conducted by the National Institute of Zoology and Botany of Academia Sinica during 1943 can be grouped into six sections, namely, ichthyology, entomology, protozoology, phanerogamic botany, algology, and cytology. The results are presented in epitome as follows:

Ichthyology

For four successive years the important edible fish, *Monopterus javanensis*, has been the main object of study. The anatomy as well as the physiology of its accessory respiratory organ, namely, the bucco-pharyngeal epithelium, its breeding habits and metamorphosis and the function of its larval organs have previously been discussed. In 1943, the whole blood vascular system was carefully worked out, and earlier accounts have required considerable modification. The integumentary serous glands of this fish, with their peculiar distribution around the pericardial region, were studied, and the hatching phenomena with which these glands are chiefly concerned were described. Particularly interesting was an investigation on the sexuality of this fish; Monopterus starts its life always as a female, undergoes sex-reversal after laying eggs, becoming eventually a male. Its growth-rate under natural condition was also studied simultaneously.

As a proof of the capability of hypertonic excretion in a purely freshwater teleost as a means of osmotic regulation, the paradise fish, *Macropodus opercularis*, was shown in 1942 to produce a crop of chloride-secreting cells in its gill lamellæ when it is acclimatized in a strong sodium chloride solution. In order to ascertain whether the secretory activity of these cells is limited to chloride alone, as their name implies, the same experiment was repeated with sodium sulphate instead of chloride; the result suggests that secretion is not limited to chloride (see NATURE, Feb. 26, p. 252).

An ichthyological survey has been made in the region covering Western Szechwan and Eastern Sikang. No less than a hundred species, including ten new ones, were collected and described. A comparative study of the much modified pectoral and pelvic girdles of the Homalopterid fishes, which are adapted with remarkable success to life in torrents, is now being carried on, in the hope of elucidating the phylogenetic relationship within the group.

Entomology

In systematic entomology, much emphasis has been laid on the white flies, Aleurodidæ, the fruit flies, Trypetidæ, and the leaf beetles, Chrysomelidæ. Investigations on the white flies of Szechwan and on the cucumber beetles of China have already been completed, and have proved of value not only to insect taxonomy as a whole, but also to the economic position of the groups studied.

Morphological investigations of insects have also been undertaken. The study of Malpighian tubes in Chrysomelidæ has helped to clear up the systematic position of the sub-family Eumolpinæ. In the study of the tibial tympanic organ of Conocephalus, attention has been directed particularly to the structure of the crista acustica and to the functional aspect of the whole organ. Comparisons of the elytral tracheation of Dermaptera with that of Protelytroptera, a Palæozoic order, were made, and the possibility of the Dermaptera being derived from Protelytroptera was taken into consideration.

Some experiments were conducted to demonstrate the effect of light on orientation of the cicada *Cryptotympana pustulata*, and also the change of position exhibited by aphids during feeding. Inquiries were likewise attempted with regard to the part played by the elytra of Coleoptera during flight, and by the jumping spiders in checking the spread of house-flies and mosquitoes. Observations on the mode of egg-laying of the aquatic bug, *Sphærodema rustica*, show that coition is immediately followed by the act of oviposition; the two acts take place alternately and continuously, both activated by the male, and not by the female as generally believed. The problem of respiratory adaptation was investigated in another water bug, Cheirochela sp. This bug, being incapable of rising to the surface of water to obtain atmospheric air, has been obliged to overcome the difficulty by the development of pubescence on the thorax and abdomen for collecting air-bubbles under water, by the modification of certain parts of the integument to permit cutaneous respiration, and, most important of all, by the specialization of the legs to function as tracheal gills.

Protozoology

In the field of protozoology, work has been confined mostly to the dinoflagellates and Infusoria. For the former, studies have been centred in the thecal morphology of dinoflagellates, especially in the plates that constitute the ventral area, which has rarely been scrutinized by previous investigators. The thecal plates of a number of species belonging to Diplopsalis and to Ornithocercus were analysed and their number and arrangement determined. All the specimens studied were collected from the Hainan region during the years 1933 and 1934.

Surveys of infusorian fauna of Pehpei and other localities of Szechwan have been made from time to time. Five new species of epizoic ciliates were described. They are found attached either to the antennæ, legs and swimmerates or to the gills of the freshwater shrimp, *Palæmon nipponensis*. Other problems now being studied are the freshwater Sarcodina of Szechwan and the peritrichous Infusoria of Pehpei.

Phanerogamic Botany

The Umbelliferæ have been the main subject of investigation among the flowering plants. Aside from a general survey of Chinese umbellifers, the species of Bupleurum and Ligusticum, known as native drug plants, were separately treated. The anatomy of seedlings of *Coriandrum sativum*, *Fœniculum vulgare*, etc., has also been investigated. The results add much to our knowledge of the development of vascular bundles of the family Umbelliferæ as a whole.

In collaboration with the Kansu Provincial Government, a forest survey is now in progress in that province. Work is proceeding on utilization, growth-rate, and fungal diseases of timber trees. Land classification, stand and composition of the existing forests, and dendrological characters, which are exceedingly important for the formulation of forest management plans, are also being examined.

Algology

The section of algology dealt largely with the systematics of freshwater algæ. About 1,500 species were collected from different localities of Kwangtung, Kwangsi and Szechwan, and, among them, 4 genera, 75 species, and 24 varieties were described as new. Asterocapsa, a new genus of Myxophyceæ, is worthy of notice as it has reproductive cells with much the same appearance and mode of development as the more advanced autospores of Chlorophyceæ. Other three new genera, Hormothece, Brachytrichiopsis and Symphyonema, representing transitional forms of certain families, are deemed to be phylogenetically important.

Since 1941, attention has also turned to the study of algal ecology. Observations on algal communities of the Kialing River have been made at regular intervals. As affected by the condition of river-bed, the velocity of water currents, and the intensity of light, the distribution of algæ in this river naturally falls into seven distinct communities, always isolated and never forming horizontal adjoining zones like those prevalent in stagnant waters. Each community consists of only a single or very few dominant species. In addition, the seasonal distribution of algæ in a freshwater pond was thoroughly studied. Temperature, sunlight and rainfall are factors influencing the periodic occurrence of the species of phytoplankton.

Cytology

In the field of cytology, investigations on the number and behaviour of meiotic chromosomes of *Brachytrupes portentorsus* and the meiotic division in *Gesonia punctiforons* have been completed. The former demonstrates the number and structure of autosomes and the behaviour of the *X*-chromosome, whereas the latter deals especially with chromonema structure and the time of its splitting. In both cases the so-called chromomeres are believed to be mere artefacts or twists in the chromatids.

TRADE AND ECONOMICS IN THE INTERNATIONAL SPHERE

THE Economic, Financial and Transit Department of the League of Nations has issued two studies in a series on international trade and commercial policy with the view of contributing to those objectives of commercial policy, "the elimination of all forms of discriminatory treatment in international commerce" and "the reduction of tariffs and other trade barriers", which have found fresh expression in the Mutual Aid Agreements. The first of these, "Quantitative Trade Controls: their Causes and Nature"*, by Prof. G. Haberler, of Harvard University, in collaboration with Mr. M. Hill, considers what were the forces which induced Governments to adopt these measures of quantitative control; what were the relative advantages and disadvantages of such restriction compared with tariffs and other measures designed to influence trade through the price mechanism; whether quantitative controls were the most suitable instrument, and why they were so generally condemned both by international conferences and by economists, the likelihood of their adoption after the present War and the policies which should then be pursued.

This study leads to the conclusion that if the trend towards economic isolation, autarky, regimentation and State control, characteristic of the nineteen-thirties in many parts of the world, were to be renewed after the War, quantitative trade controls would necessarily take an ever-greater role. A movement in this direction would not only belie the intentions of the Governments of the United Nations as expressed in the Atlantic Charter and the Lend-Lease Agreements as well as innumerable statements of national policies; it would also prevent the achievement of those basic economic and social objectives which most of them have proclaimed—greater human welfare and full employment, within the framework of a social system designed to preserve individual liberty. These ends cannot be attained without an expanding international trade. Except over short periods, we cannot have generally regimented and socialized international trade and a domestic economy based on free enterprise.

Many countries may find it necessary to maintain exchange controls for a considerable time after the War as regards capital movements. If effective machinery is established to overcome the initial difficulties of financing the essential needs of countries left after the War without adequate means of external payment, and to facilitate multilateral clearing, it should be possible to liberate commodity trade rapidly from control via the exchanges. Of the circumstances facilitating a removal of import quotas a growth in exports appears to be the commonest, and the whole history of commercial policy in the inter-war period confirms the view that the difficulties in scaling down the barriers to trade are least formidable in times of rising prosperity.

In the period considered, the most clearly discernible factor leading governments to introduce quantitative controls was currency instability accompanied by exchange dumping. A primary cause of the currency instability was the breakdown of the mechanism of international trade and settlements as a result, first of the war dislocation and second of the catastrophic fall in prices. Discrepancies in national price structures can only be overcome by changing prices in terms of domestic purchasing power, or by changing the external purchasing power of currencies by a modification of the exchange-rates. This is one reason in favour of the establishment of special machinery by means of which credit may be furnished to meet changes in the balances of accounts, by which orderly changes in currency parities may, if necessary, be carried through, by which national monetary policies may be co-ordinated and kept in line, and multilateral trade and clearing facilitated.

Such machinery requires for its effective working concerted measures against economic depressions and for the maintenance of full employment, and these elements in a possible long-range plan for the preservation of an international economic system provide a challenge to the constructive vision and the co-operative spirit of our generation. The failure to break down the system of quantitative restrictions in the 'thirties was due not so much to a lack of understanding of the technical issues at stake as to the unwillingness of certain great States to abandon their designs for political aggrandisement or the methods by which they are able to exercise pressure on others. Wise concerted economic measures are one of the bases of a durable peace; but they provide by themselves no solution of the political problem on which the success of all efforts to create a better economic world ultimately depends.

* League of Nations, II, A.5; 1943. Pp. 45. (London: George Allen and Unwin, Ltd.) 2*s*. 6*d*.

In the second study, "Trade Relations between Free-Market and Controlled Economies"*, Prof. J. Viner analyses the difficulties which in the nineteen thirties confronted countries maintaining a substantially free trading system and relying primarily on the tariff method of trade regulation; it supplements a critical appraisal of the attempts made to meet these difficulties with constructive proposals for the future. There may be, from the national point of view, a case for national resort to direct foreign trade controls under conditions of world-wide depression, of over-valued and unstable currencies, of collapse of international credit facilities, of imminent threat of war, of the prevalence of similar controls in many other countries, and of the absence of any promise of effective concerted action to obtain relief from these evils; but Prof. Viner regards these direct methods as in general injurious to world prosperity and as barriers to international economic collaboration and harmony. Their substantial elimination is a prerequisite for the attainment of a peaceful and prosperous world.

Against all three major types of direct government regulation of foreign trade—exchange controls applied to commercial transactions, import quota systems, and government monopolies of foreign trade—six charges may be made, in different degrees. They 'tie up' diplomacy closely with the detailed conduct of foreign trade and thus promote international controversy and facilitate the injection of political and military considerations into trade relations. They lend themselves more effectively than ordinary import duties to the application of monopolistic methods to foreign trade, to the economic injury of the world as a whole. They promote bilateralism in foreign trade at the cost of multilateral trade and of the suppression of profitable foreign trade. They lend themselves to discriminatory treatment of the trade of different countries for economic or political purposes. They promote or require the development of internal monopolies and the restriction of the field for private enterprise, and especially small-scale enterprise. Finally, by placing other countries not following similar practices in a position of relative disadvantage in trade-bargaining, they tend to spread these practices to other countries.

Hope for better results from future attempts to obtain reform in this field must depend in part on the attainment, through provisions for collective security, of a reasonable expectation of a peaceful world. It must also depend on reduction of the levels of ordinary import duties in high tariff countries, on the attainment of substantial stabilization of currencies, on the establishment of procedures for concerted action to deal with mass unemployment and on provision of reasonable facilities for international credit. Rapid progress in the elimination of direct controls by bilateral negotiation cannot be expected unless greater success is attained in formulating and obtaining acceptance of unambiguous, rational and easily enforceable criteria for determining the absence or presence of discrimination and of the illegitimate use of monopoly power in trade relations; and unless there emerges from the bilateral negotiations a common pattern of policy with respect to relations with countries which continue to adhere to rigorous direct controls of their foreign trade. Equally the participating countries in their bilateral negotiations must also consider not only the protection of of their own export trade from discrimination or from monopoly pressures, but also the need for refraining from pressing for, or from accepting, concessions which involve discrimination against innocent third countries.

Prof. Viner sees brighter prospects of success in an attempt to deal with the problem in a multilateral conference. Such a conference would have as objective multilateral agreement binding the participating countries to move towards the elimination of direct controls on a mutually agreed time-schedule; to define the practices which would not be permissible in their trade relations with one another; to formulate the procedures to be followed in trade relations with non-participating countries adhering to direct controls; and to participate in the establishment of an international agency, to which questions of violation of the convention, of revision of its terms, and of admission of new countries could be referred. The technical difficulties of framing and administering a multilateral agreement of this kind would be comparatively moderate if wide acceptance could be obtained for definite and unqualified outlawry of the questionable practices, at least after a transition period had elapsed. Further progress in obtaining significant agreement in this field may be impossible except as international agreement is reached in other fields of international economic relations, notably in limiting the heights of ordinary tariffs, in establishing international credit facilities for monetary stabilization and for long-term investment purposes, and for collaboration in dealing with the problem of the business cycle and of mass unemployment. Slow progress need not be fatal, provided there is early agreement on the direction in which movement shall take place, and on procedures of negotiation which will assure that the achievement of one stage of reform will lead promptly to endeavours to accomplish the next stage.

* League of Nations, II, A.4; 1943. Pp. 92. (London: George Allen and Unwin, Ltd.) 4s. 6d.

INDUSTRIAL POISONS

THE delivery by Dr. Donald Hunter of the Croonian Lecture of the Royal College of Physicians for 1942 was prevented by the War: but it is now printed (*Quart. J. Med.*, 12, 185; Oct. 1943). Remarking that the medical man of to-day must know something of the dangers of working in chemical, metallurgical, aircraft, munitions, ceramics, textile, cellulose lacquer and moulded plastics industries, Dr. Hunter points out that new materials for industry are frequently being discovered and used, and that their dangerous properties may not be realized until some workman loses his life or becomes severely ill. The medical man practising in an industrial area may have to deal with symptoms produced by substances which even the chemists may not fully understand. Such substances may attack the workman through his skin or lungs; some of them attack the liver, kidneys, blood or bone marrow. The toxicologist has to add to his medical equipment a considerable knowledge of chemistry and of the processes of various trades as well.

Dr. Hunter discusses the effects of lead, arsenic and mercury among the metals; among aromatic compounds he deals with benzene and its amino- and nitro- derivatives and also tri-*ortho*-cresyl phosphate; he concludes with the chlorinated hydrocarbons and substances of the glycol group. It is, of course,

impossible in a short article to summarize the results of experimental work and the wealth of other information contained in this lecture, which tells us many interesting things about industry as well as about toxicology.

It is interesting, for example, to note that the substitution of machine for hand labour has abolished lead poisoning among some kinds of lead workers and that, since 1899, the lead manufacturers of Great Britain have spent more than £200,000 on measures designed to provide healthier conditions for their employees. On the other hand, new methods and new industries have introduced new causes of lead poisoning. Motorists will note that spray painting of cars with leadless cellulose paints has reduced the incidence of lead poisoning in this trade, but the use of a lead and tin solder to strengthen steel motor-car bodies has created a new hazard. There is little risk of poisoning by the exhaust gases of car engines using petrol to which tetra-ethyl lead has been added, although it must not be used for cleansing the skin. Householders will be glad to know that aniline colours are now generally used to colour wall-papers, so that there is little risk of the symptoms once produced by living in rooms papered with wall-papers containing cupric arsenite. The mould *Penicillium brevicaule*, growing in the paste of such wall-papers, liberated dimethylarsine from the arsenical compounds used in the colours. It is worth noting, however, that, so late as 1931, a child died in the Forest of Dean from inhalation of dimethylarsine from the mouldy walls of a damp house, the arsenic having come from coke breeze used in the plaster of the walls. For this reason the use of concrete blocks containing coke breeze and the addition of arsenious oxide to cements to make them harden more quickly are not desirable.

It is in the field of the coal-tar derivatives that the toxicologist is hard put to it to keep pace with the chemist who produces them. Benzene, which must be carefully distinguished from benzine, is of outstanding importance, because of its destructive effect on the bone marrow.

Dr. Hunter states that medical workers all over the world are urging the abandonment of its use as a solvent. The same advice has recently been given by Drs. Hamilton-Paterson and Ethel Browning (*Brit. Med. J.*, March 11, 1944, p. 349). After two years of work on the effects of the inhalation of benzene used in rubber solutions in thirteen British factories, these authors conclude that some other solvent, such as solvent naphtha, should be substituted for benzene, which can cause permanent damage to the bone marrow; they recommend, among other precautions, that the blood of workers using benzene should be examined every six months. Further details about the effects of benzene are given by Dr. Hunter, who deals also with the dangers of the use of other coal-tar derivatives employed in industry.

It is interesting to learn that German factory workers at Münster, who were suffering from a shortage of fats, took home from their place of work a fat substitute and used it for frying potato pancake; they suffered from poisoning by tri-*ortho*-cresyl phosphate. In 1931, Continental women seeking abortion were poisoned by this substance, occurring as an adulterant of apiol, and in 1937 its presence in soya bean oil used for cooking caused other cases of poisoning in Natal. Many will remember the poisoning of some 15,000 people in the United States in 1930, when they took samples of a drink called Jamaica Ginger ("Jake") adulterated with tri-*ortho*-cresyl phosphate.

The chlorinated hydrocarbons will interest the general public because of their extensive use as refrigerants, fire extinguishers, cleaning agents and so on. Many of them are liver poisons. Carbon tetrachloride, which is the least harmful of them in practice, is used in fire extinguishers, in dry shampoos and as a household cleaning agent; it is also a valuable anthelmintic. The most dangerous of them is tetrachlorethane, which is also used in fire extinguishers, and as a dry cleaner and parasiticide. Its use for making waterproof coatings for aeroplane wings has been discontinued since 1917; in 1914 it caused poisoning of workers in this trade.

Dealing with substances of the glycol group, Dr. Hunter points out that, since 1925 or so, a great new aliphatic chemical industry has grown up, which is bigger than the coal-tar or aromatic industry, and this has produced a host of new solvents used in the textile, artificial silk, lacquer and celluloid industries, and in dyeing and dry cleaning and the making of paper, linoleum, polishes, cements and glues, cosmetics and other things. One substance of this group, dioxan, has a particular interest to laboratory workers, who may use it during the process of embedding material for section-cutting.

A bibliography extending to six pages adds greatly to the value of this detailed and very interesting paper. Apart from its value to industrial medicine, it should be read by the chemist, the manufacturer, the biologist and the social worker as well.

G. LAPAGE.

SMALL ERMINE MOTHS IN IRELAND

BRYAN P. BEIRNE has recently published an illustrated article* on certain species of these moths which belong to the genus Hyponomeuta. All stages of the three species, *H. padella* L., *H. cognatella* Hübn. and *H. evonymella* L., are distinguished; but the paper is mainly concerned with the biology and control of the first-named. In an outbreak of *H. padella* on hawthorn in Co. Dublin, an average of more than 95 per cent of the larvæ were destroyed by birds including starlings and other kinds. Of the remaining larvæ and pupæ about 50 per cent were killed by other enemies, including a species of Gregarina, which was found to be the most important single enemy of the larvæ after birds. Some 10 per cent and probably more were accounted for by this protozoan. An average of 3 per cent were destroyed by the well-known polyembryonic Chalcid parasite *Ageniaspis fuscicollis* Dalm.—the number bred out from individual Hyponomeuta larvæ ranging from 35 to 87. Some 3 per cent of the larvæ were also killed by the ichneumon *Angitia armillata* Grav. Less than 1 per cent were killed by other parasitic insects, including another species of Angitia, a species of Apanteles and what appeared to be Tachinid larvæ. A large proportion of the pupæ of the Hyponomeuta were killed by the predaceous larvæ of a sarcophagid fly, apparently *Agria mamillata* Pand. The ichneumon *Herpestomus brunnicornis* Grav. killed 8 per cent of the pupæ and *Pimpla turionellæ* L. 2 per cent of them. The immature stages of the parasites and predators are described and figured, together with

**Econ. Proc. Roy. Dublin Soc.*, 3 (Dec. 1943).

the adults of most of them. Some 4 per cent of the Hyponomeuta larvæ and 5 per cent of the pupæ died from unknown causes.

The causes of outbreaks of Hyponomeuta are discussed. Outbreaks appear suddenly, and it is thought that in a particular year the greater proportion of the larvæ escape attack by birds. Heavy outbreaks are always eventually controlled by parasites. But the parasites do not multiply at the same rate as the moths, and it is usually several years before they are sufficiently abundant to check an outbreak, and several additional years before they reduce it.

FORTHCOMING EVENTS

Thursday, March 30—Tuesday, April 4

BRITISH PSYCHOLOGICAL SOCIETY (at the Training Centre, Jordanhill, Glasgow, W.3).—Annual General Meeting.

Saturday, April 1

BRITISH ASSOCIATION OF CHEMISTS (LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. R. G. W. Norrish, F.R.S.: "Chemistry and the Community".

Monday, April 3

SOCIETY OF CHEMICAL INDUSTRY (AGRICULTURE GROUP) (joint meeting with the FOOD GROUP AND LONDON SECTION) (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 2.30 p.m.—Mr. W. E. Rhodes and Mr. A. F. Davies: "The Selection and Pre-processing of Potatoes for Canning, with special reference to Control of Texture by Calcium Chloride"; Mr. F. Hirst and Mr. W. B. Adam: "The Processing and Laboratory Examination of Canned Potatoes".

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. N. Cotton: "The Planning of Working Hours".

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre Swiss Cottage, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.15 p.m.—Mr. J. Rubinstein: "Modern Trends in Electrical Insulation".

Tuesday, April 4

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. J. W. Layard: "Song and Dance in Malekula".

Wednesday, April 5

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Sir Walter Langdon-Brown: "William Gilbert (1544–1603) and his Position in the Medical World"; Prof. Sidney Chapman: "William Gilbert and the Science of his Time".

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. D. Gabor: "Energy Conversion in Electron Valves".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE TEACHER OF GENERAL SUBJECTS, particularly MATHEMATICS—The Principal, Leicester College of Technology and Commerce, Leicester (April 5).

GRADUATE LECTURER IN MECHANICAL ENGINEERING at the Lincoln Technical College—The Director of Education, City Education Offices, 4 Lindum Road, Lincoln (April 6).

ASSISTANT MASTER or MISTRESS on the staff of the Day School to teach MATHEMATICS and some PHYSICS up to School Certificate standard—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (April 11).

ENGINEERS with good Degree and some Research experience, preferably in HYDRAULICS, for Research and Development Department of large Engineering concern (location, Newcastle area)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2011XA) (April 12).

DIRECTOR OF THE ART GALLERY AND MUSEUMS—The Town Clerk, Council House, Birmingham 1 (endorsed 'Art Gallery Director—Room 1') (April 12).

CHIEF ENGINEER, ELECTRICAL AND MECHANICAL, by the Jamaica Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.788A) (April 12).

LECTURER OF STATISTICS (temporary, full-time) to take charge of the teaching of Statistics—The Registrar, The University, Liverpool (April 14).

RESIDENT LECTURER IN CHEMISTRY—The Principal, Newnham College Cambridge (April 15).

UNIVERSITY LECTURER IN ANTHROPOLOGY—The Secretary of the Appointments Committee Faculty of Archæology and Anthropology, Museum of Archæology and of Ethnology, Cambridge (April 15).

SENIOR LECTURER IN NATURAL SCIENCE at the Hull Technical College—The Director of Education, Guildhall, Hull (April 15).

HEADMASTER of the Junior Technical School, Doncaster—The Chief Education Officer, Education Offices, Doncaster (April 15).

ASSISTANT MASTER FOR TECHNICAL SUBJECTS in the Municipal Technical College—The Secretary, Education Office, Town Hall, Widnes (April 22).

CHAIRS OF MATHEMATICS, PHILOSOPHY and PHYSICS, tenable at Bedford College for Women—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (April 24).

ASSISTANT MASTER to teach MATHEMATICS at any stage up to University Scholarship work at the City of London School—The Town Clerk, 55–61 Moorgate, London, E.C.2 (May 1).

DRUMMOND PROFESSORSHIP OF POLITICAL ECONOMY—The Registrar, University Registry, Oxford (May 13).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

BROADCAST ENGINEERS (male) by Government for service in Far East—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O S.90).

LECTURE ASSISTANT IN THE PHYSICS DEPARTMENT—Prof. H Dingle, Imperial College of Science and Technology, Imperial Institute Road, South Kensington, London, S W 7

ASSISTANT TEACHERS to take MATHEMATICS, MECHANICAL DRAWING, GENERAL SCIENCE, and GEOGRAPHY, in a Special Course in the Stroud District for R A.F. Students—The Secretary, County Education Office, Shire Hall, Gloucester.

PSYCHIATRIC SOCIAL WORKER for Child Guidance, Delinquency and other Child and Adult cases—The County Medical Officer, 4 Barnfield Crescent, Exeter.

ASSISTANT TEACHERS for (1) ENGINEERING SUBJECTS, (2) MATHEMATICS AND SCIENCE, at the Staple Hill Junior Technical School, near Bristol—The Secretary, County Education Office, Shire Hall, Gloucester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences), Vol. 62, Part 1, No. 5: On Whittaker's Solution of Laplace's Equation. By E. T. Copson. Pp. 31–36. (Edinburgh and London: Oliver and Boyd.) 1*s*. [103

Transactions of the Royal Society of Edinburgh. Vol. 61, Part 1, No. 5: Studies on the Soils Developed on Basic Igneous Rocks in Central Aberdeenshire. By Dr. Robert Glentworth. Pp. 149–170. (Edinburgh and London: Oliver and Boyd.) 6*s*. [103

Memorandum and Articles of Association of Institute of Medical Laboratory Technology. Pp. iv+34. (Wakefield: Institute of Medical Laboratory Technology.) [133

The Development of British Universities. By Sir Ernest Simon. Pp. 20. (London: Longmans, Green and Co., Ltd.) 1*s*. net. [133

Quarterly Journal of the Royal Meteorological Society. Vol. 70, No. 304: Report on the Phenological Observations in the British Isles from December 1942 to November 1943. By Major H. C. Gunton. Pp. 32. (London: Royal Meteorological Society.) 3*s*. [133

Agricultural Education. Statement by the Executive of the National Union of Teachers on the Report on Post-War Agricultural Education in England and Wales. Pp. 20. (London: National Union of Teachers.) [133

Chemicals in War and Reconstruction. Pp. 28. (London: Association of Scientific Workers.) 3*d*. [133

Other Countries

Ministry of Finance: Survey of Egypt. Paper No. 46: The Use of the Conformal Sphere for the Construction of Map Projections. By J. H. Cole. Pp. iii+31. (Giza: Ministry of Finance.) [63

Ministry of Public Works, Egypt: Physical Department. Paper No. 43: The Nile Basin. Vol. 6: Monthly and Annual Rainfall Totals and Number of Rainy Days at Stations in and near the Nile Basin for the Period ending 1937. By Dr. H. E. Hurst and R. P. Black. Pp. vii+613. (Cairo: Government Press) P.T. 50; 10*s*. [63

South African Journal of Science. Vol. 40: Being the Report of the Forty-first Annual Meeting of the South African Association for the Advancement of Science, Johannesburg, 1943, 28th and 29th June. Pp. xxvi+396. (Johannesburg: South African Association for the Advancement of Science.) 30*s*. net. [63

Carnegie Corporation of New York. Report of the President, the Secretary and the Treasurer for the Year ended September 30, 1943. Pp. 116. (New York: Carnegie Corporation.) [63

City of Durban: Durban Museum and Art Gallery. Annual Report for the Year ended 31st July 1943. Pp. 8+4 plates. (Durban: Durban Museum and Art Gallery.) [63

Continental Drift and Plant Distribution. By Douglas Houghton Campbell. Pp. 44. (Stanford University, Calif.: The Author, Stanford University.) [73

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 168: A Survey, Census and Statistical Study of the Horticultural Plantings on the Murrumbidgee Irrigation Areas, New South Wales. By A. Howard and G. A. McIntyre. Pp. 88+7 plates. Industrial Chemistry Circular No. 4: Separation of Ergot from Rye Corn. By Enid C. Plante and K. L. Sutherland. Pp. 12. (Melbourne: Government Printer.) [93

NATURE

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THE INTERNATIONAL LABOUR ORGANIZATION AS A SOCIAL FORCE

A SIGNIFICANT passage in the recent report of the Conservative Central Committee on Post-War Problems, "Work: The Future of British Industry", recognizes the importance of strengthening existing institutions such as the International Labour Organization. The recent conference in London of the governing body of the International Labour Office has done something to bring more to the forefront a body the potentialities of which for reconstruction and the re-establishment of world order appeared to be in danger of being overlooked. Mr. Eden and other Government spokesmen have from time to time referred to those possibilities, notably in the debates in Parliament on economic reconstruction last year, but despite an admirable series of reports from the International Labour Office and the League of Nations, there have been few signs that practical steps are being taken to utilize the services of the International Labour Organization and to expand them where required to deal with the problems of relief or resettlement. The reference to the International Health Organization in the report of the sub-committee of the United Nations Relief and Rehabilitation Administration on policies with respect to health and medical care which has been included in the recently published report of that body* is not satisfying. While it welcomes co-operation with existing international health agencies and recognizes that the Health Organization of the League of Nations and the Industrial Health Section of the International Labour Office have much to offer on the basis of their experience and accomplishments, it does not encourage much confidence that such co-operation will in fact be fostered, or that new organizations will not be established where existing organizations might serve.

The decision that the governing body of the International Labour Organization is to meet and arrange for a full International Labour Conference next summer should dispose of the fear, entertained not without some reason, that the major Governments of the United Nations would allow the International Labour Organization to dwindle away in favour of new *ad hoc* organizations. The decision also represents, besides the preservation of continuity in international life, the formal association of employers and workers, as distinct from their governments, in post-war reconstruction. The bringing together of governments and occupational or technical groups, on which Mr. Bevin laid much stress in welcoming the delegates to the governing body at its opening meeting, may well be of decisive importance to the functional approach to international problems which now finds general favour, as well as in building up a moral force behind international law itself.

* United Nations Relief and Rehabilitation Administration. Resolution and Reports adopted by the Council at its First Session, held at Atlantic City, New Jersey, U.S.A., November 10 to December 1, 1943. (Miscellaneous No. 6, 1943. Cmd. 6497. London: H.M. Stationery Office, 1943. 1s. 3d.)

Much more indeed may flow from this termination of the neglect of the International Labour Office, for its brilliant studies and reports such as "The I.L.O. and Reconstruction", "Wartime Developments in Government-Employer-WorkerCollaboration", "Wartime Transference of Labour in Great Britain" and "Approaches to Social Security", have fairly established its reputation as a leading world centre, even during the War, for research into labour and social problems and for the dissemination of accurate and unbiased information. There must obviously be some adjustment of the relative spheres of, and the co-ordination between, the International Labour Office and the Relief and Rehabilitation Administration, the Permanent Organization on Food and Agriculture, and the other economic agencies to be set up. But beyond this, there must be hard thinking on the forms of international organization which the United Nations propose for the general welfare after the War.

If the International Labour Organization is to make the contribution to world co-operation and the elimination or minimizing of those strains in the economic and social structure of the world that tend to international friction and misunderstanding which the reports already referred to have suggested, important work must be done both at the International Labour Conference and before it meets. The growing social consciousness has strengthened the tendency to regard the International Labour Organization as a vital international agency and the desire for closer international co-operation in labour matters. Mr. Bevin asserted that the Organization must become the body charged with the duty of assisting governments by advice to give effect to that article of the Atlantic Charter under which the United Nations seek to "bring about the fullest collaboration between all nations in the economic field with the object of securing for all, improved labour standards, economic advancement, and social security".

It is true also that functional organizations such as the International Labour Organization are important means by which the smaller Powers can take their place and exert their influence in an international community; further, the method fits the circumstances of the United States, with its readiness to co-operate in practical work of the moment and its reluctance to make formal commitments. Nevertheless, there are important obstacles still to be overcome. The absence of Soviet Russia from the International Labour Organization, due to an old technical quarrel, is one; the attitude of American Labour is another.

To overcome these and other obstacles it is essential that the future status and policy of the International Labour Office should be clearly visualized, and this should be an early item in the agenda of the forthcoming conference. There must be unequivocable decision as to whether the International Labour Office is to be just an instrument for the co-ordination of information, or whether it may become a positive international instrument of co-operation for the improvement of existing laws and conditions, the regulation of labour supply, the protection of workers against sickness, old age, and accidents, industrial welfare and safety, and labour relations. There have been sharp reminders of the way in which a backward labour policy in even one of the United Nations may hinder the great war effort now demanded of us and delay victory, while in turning to face the problems involved in post-war reconstruction and a full employment policy, we cannot but be aware that the success of measures projected in Britain will depend on social, economic and labour conditions elsewhere.

For all that, a narrow view of the functions of the International Labour Organization is still taken in some quarters, and scientific workers are far from being alive to the extent to which this affects their own direct interests. Few of them have shown much appreciation of the work which the International Labour Office has done in such technical matters as industrial safety and health, accident prevention or the like, and its careful studies of the position of professional workers, of service agreements and like matters, have largely been ignored by their professional organizations. Moreover, the suggestion advanced by Sir Frederick Leggett on behalf of the British Government at the session of the governing body of the International Labour Office on December 18, on joint industrial committees on international lines, can scarcely have its full effect without their participation.

Sir Frederick suggested that the International Labour Organization could bring together employers and workers in the coal, iron and steel, engineering, building and civil engineering, textile and transport industries. He thought that great benefit would result from employers and workers themselves dealing with each other internationally, as they now do in national industry; and Sir J. Forbes Watson, welcoming a resolution for a revision of the constitution of the International Labour Organization submitted by the workers' group, urged that the Organization should not be too conservative. Its machinery clearly requires strengthening to fulfil the mandate implicit in the Atlantic Charter, and if there is to be a wide view of its functions, its machinery must be examined in a constructive and courageous as well as critical spirit.

Such a wide view of the functions of the International Labour Organization and revision or extension of its organization does not mean an extension into the high politics of economic affairs. The line may be hard to define at times, and in the economic and social sphere technical matters often tend to pass into the political sphere. None the less, in the future as in the past, the International Labour Organization will make its best contribution to the promotion of social justice and the adoption of humane conditions of labour as envisaged when it was first established if it keeps so far as possible within the technical field, and contents itself with purely advisory functions when political action by governments appears to be necessary.

If, however, those technical functions are to be exercised most effectively, the full support of all scientific and technical workers will be essential. That contribution must be made, in the main, through their professional associations, and it is to

be hoped that in approaching the problems of post-war reconstruction, as some of them are now doing, they will take a much wider view of professional activities and responsibilities than in the past. It is not merely that past neglect of the work of the International Labour Organization in the professional field must be remedied; there must also be a much clearer and more realistic view of the functions of professional associations than has characterized them in the past. They have a distinctive technical contribution to offer, which has sometimes been as readily thwarted by political proclivities as it has been by the innate conservatism of all professional associations. The meeting of the governing body of the International Labour Organization and the forthcoming conference give a direct challenge to professional workers for the creative thinking which must precede both the re-shaping of the Organization itself and the effective functioning of technical and scientific workers in a democratic system which will adequately serve the changing needs of the post-war world.

CONTROL OF CIVIL AVIATION

International Air Transport

By Brig.-Gen. Sir Osborne Mance, assisted by J. E. Wheeler. (International Transport and Communications.) (Issued under the auspices of the Royal Institute of International Affairs.) Pp. x+118. (London, New York and Toronto: Oxford University Press, 1943.) 7*s*. 6*d*. net.

UPON agreements among the nations of the world on the future development and organization of civil and military aviation may depend the very existence of civilized progress and freedom as we know them. Upon agreements among the nations of the world, by which they yield up some part of their national sovereignty to an international controlling body, may well depend a world organizing for peace. The failure to arrive at such agreements, the demand by each nation that its national sovereignty must be kept intact in the air, on the sea, and on the land, will ultimately lead to another world war, far more disastrous in its effects than the present one—one from which, indeed, the world may not recover for many generations.

These are strong statements to make, but a little reflection will lead to the conclusion that there is some justification for them; and very little knowledge of the past and possible future developments of air transport will convince those who acquire that knowledge that there is a very serious justification for the statements.

"International Air Transport" is an important book, for it supplies in a condensed, authoritative, logical and readable form just that information which all those who have not studied deeply the implications of air transport should have in their possession before they attempt to form public opinion, or worse still, take part in the laying down of air legislation. In its twelve chapters, the book contains the most concise, and documented, summary of the development of civil aviation, its failures and successes and its political repercussions, which has yet appeared.

The difficulty of arriving at a solution of international air traffic and control is nothing like so great technically as it is politically. In the past, civil aviation has been used as an instrument of policy, often closely linked with military aviation, and civil air lines have been used to give military pilots intimate experience of routes over which they have to fly in war. To quote from the book:

"Perhaps the most striking and extensive use of aviation for economic, political and military penetration was made by Germany in Latin America. Partly through the direct action of the Lufthansa, partly through numerous highly subsidized companies under Lufthansa control thinly veiled by national façades, partly through the grant of extensive long-term equipment loans to these virtual subsidiaries, and to other local companies when in need of financial assistance, German control of aviation extended to nearly every South American country. A large proportion of the technical and flying personnel were either Germans or Germans who had been nationalized in a South American country for expediency's sake. . . . An attempt was made to secure a contract from the Ecuadorean Government to operate a service to the Galapagos Islands which could have no possible commercial justification, but the Islands happen to lie in a highly strategic position just off the Pacific entrance to the Panama Canal . . . since the outbreak of war, German air activities in America have been largely eliminated by expropriation and other measures".

Now it could quite easily have been argued that this South American development on the part of Germany was purely the altruistic one of commercial expansion, and it may be a difficult argument to combat.

In the past, two methods have been suggested to control civil aviation with the view of abolishing also the chances of air warfare. One has been by international regulation and supervision of the manufacture and export of aircraft, and the other international organization of air transport. Attempts to carry out both these methods have failed; largely because it was believed that there was not enough difference between military and civil aircraft, and that any nation allowed to construct the latter could easily adopt them for the former. This reason is far less strong to-day than it was. Any present-day civil aircraft would make a poor military aeroplane for fighting and bombing purposes. But the danger still remains that civil transport machines, of the many varieties which will be developed, could be used for the transport of troops, munitions and guns.

It is becoming increasingly clear that only by some world-wide authority, overriding that of any particular nation, and provided with the necessary power to enforce its decisions, can the menace from the air be prevented; that is, the formation of an international air police force which would supervise the observance of civil air regulations and decisions regarding aircraft construction. As the authors point out, this police force would be quite different from whatever international military force may be created for protection against aggression.

The world stands at the cross-roads of aviation, and upon which road the nations decide to take may well depend the future of the world. It is to be hoped that the United Nations have already prepared the basis for an international co-operation and control which will prevent any nation becoming aggressively active at the terrible speed which aviation will enable it to be.

This is a book which should be widely read.

J. L. PRITCHARD.

FOOD-POISONING

Food-Poisoning

Its Nature, History and Causation, Measures for its Prevention and Control. By Elliot B. Dewberry. Pp. viii+187+17 plates. (London: Leonard Hill, Ltd., 1943.) 15*s*.

TO the Ancients, food-poisoning meant, as the name implies, the intentional adulteration of food with some deadly poison, and official food-tasters were still in vogue up to the Middle Ages. In the nineteenth century it was noticed that acute attacks of diarrhœa and vomiting followed the ingestion of certain foods, and the illness was blamed on ptomaines, the toxic alkaloids which are formed when foods are in an advanced stage of putrefaction. Later it became apparent that outbreaks of gastro-enteritis frequently followed the eating of apparently normal food, and just over half a century ago, when bacteriology was still in its infancy, Salmon, in the United States, and Gaertner, in Austria, showed that these alimentary upsets were due to certain bacteria (since called the Salmonella) and their toxins. About the same time van Ermengen, in Belgium, proved that the neuro-paralysis which frequently followed the eating of German sausage was due to the powerful toxin of an anaerobic sporing bacillus which he called *B. botulinus*, and the disease botulism. In the past fifty years much has been added to our knowledge of this type of food-poisoning, perhaps better called food infection or intoxication, and this knowledge has been collected and admirably arranged by Mr. Dewberry, together with sections on food-poisoning with metals, poisonous plants including the fungi, poisonous fish and shellfish, food allergy, and the contamination of food by war gases.

In dealing with the most common form of bacterial food-poisoning, that characterized by an attack of diarrhœa and vomiting within twenty-four hours of eating the peccant food, the author describes first the responsible bacteria—the Salmonella family, now more than 120 strong, certain Staphylococci, and certain strains of Proteus—some of which produce the syndrome early because the toxins are already formed in the infected food, while others, ingested with the food, produce their toxin in the gut, so that the onset of symptoms is delayed for 6–24 hours. The most common vehicles of infection nowadays are milk and milk products, or *prepared* meats (pies, sausage, brawn, boiled ham, etc.) which have been contaminated by human or animal carriers, and which act as culture media for these food-poisoning bacteria. Less often the infection is present before the animal is slaughtered for food and, because calves are particularly liable to Salmonella infection, veal is most likely to be infected in this way. The difficulty in sterilizing infected meat, particularly in a pie, is pointed out.

On the other side of the picture, the great improvement in the canning industry has meant that infection of tinned food before the tin is opened is now uncommon. No cases occurred among British or Allied troops during the War of 1914–18 despite the enormous amount of tinned food that was consumed.

In regard to sources and reservoirs of infection, Mr. Dewberry quite rightly stresses the importance of human convalescent carriers and mild 'missed' cases; but chronic Salmonella carriers must be extremely rare. Rats, mice and ducks are other sources of infection, and the house-fly, as carrier, must not be forgotten. The machinery for investigating and controlling food infections is fully discussed, with bacteriological technique given in an appendix. Food-poisoning due to the contamination of food with metals is, with the possible exception of lead and arsenic, quite rare, because metals are rendered inert by combination with the protein in the food. Botulism gets forty-eight pages, although it is a very rare infection in Britain—only one small outbreak has been reported since the Loch Maree tragedy in 1922. The organism is found in the soil of most countries, and, in recent years, many cases of botulism in America have been traced to infection from home-canned fruits and vegetables due to the fact that the spores of the organism require several hours' heating at 100° C. to destroy them. They are, however, much less resistant in an acid medium.

This is a book which in its lucidity and simplicity of language should appeal to the interested layman as well as to the medical expert. Its pages are enlivened by photographs of many pioneers in this branch of medicine, including a goodly sprinkling of Englishmen, but not, unfortunately, of Salmon.

ROBERT CRUICKSHANK.

PLASTICS

Plastics in the Radio Industry

By E. G. Couzens and Dr. W. G. Wearmouth. ("Electronic Engineering" Technical Monographs.) Pp. ii+58. (London: Hulton Press, Ltd., 1944.) 2*s*. 6*d*. net.

THIS, the second of the technical monographs issued by the publishers of *Electronic Engineering*, does not quite justify its title, for although it contains a full description of the types of plastics, their methods of manufacture and processing, and their general physical properties, their uses in the radio industry are barely mentioned. The authors, Mr. E. G. Couzens and Dr. W. G. Wearmouth, present the subject mainly from the point of view of the industrial chemist; that is, they describe plastics *for* the radio industry, rather than plastics *in* the radio industry. An amazingly gaudy frontispiece shows how dazzling to the eye is a collection of typical plastic products, but there is no discussion of their uses, and a natural desire to suppress some of the cruder decorative effects may blind one to the fact that brightly coloured insulating sleeving may serve useful technical purpose in identifying the elements of a complicated radio network.

There is, of course, much in the booklet to interest workers in the radio field, and perhaps it is legitimate to assume that they are already familiar with the kind of equipment for which such materials can be and are in fact used, and that what they most require is classified information on all the types they are likely to meet. This information is plentifully provided; the means of identifying the various plastics by heating tests, trade names and sources of supply are given, as well as the electrical and general physical properties. Experimentalists will be interested in the cements and solvents listed for the various materials, as well as some of the details of moulding, polishing and machining. A chapter on electrical properties is sufficient to outline the essential practical data, and to show the complexity of the relation between electrical properties and the factors such as temperature, frequency and molecular structure, which control them. Little attempt is made, however, to give a scientific discussion of this side of the subject.

MEDICAL AND SURGICAL ACHIEVEMENT IN THE U.S.S.R. DURING WAR*

By E. ROCK CARLING

When the fighting was at its height in Crete, 2,164 years ago, the people of Knossos applied to those of Cos, then the leading medical school in the world, for a military surgeon. Hermias, who was sent, did his duty so well that he not only saved many lives, but also by his example sustained the morale of the troops and thus contributed to victory. An inscription acknowledging his merits with gratitude is extant in Cos to this day, unless the Germans have recently removed it to grace one of their museums.

The duties of military doctors differ from those of their civilian colleagues. To relieve suffering, to save life, and to restore function, are indeed a part of their task; but there is an overriding duty—to keep every possible man in the firing line, and to return every possible man to that line at the earliest moment after injury or sickness. This may mean, for example, that a lightly wounded man has priority for attention over one so gravely injured that, though he recover, he will never return to the front.

More men leave the front as the result of sickness than of wounds. Sickness has determined many campaigns since that of Hannibal against Rome, and doubtless many before it. Thus a supremely important but undramatic part of the military medical officer's duty is concerned with sanitation in all its aspects, with such things as water supplies, and particularly with 'prevention'; from the control of flies, mosquitoes and other pests, to inoculation against specific diseases like tetanus, typhoid, yellow fever, and so on.

Modern implements of war, in their design, require the aid of physiologists and medical specialists if their full efficiency is to be achieved. It is idle to fabricate very powerful machines unless their control is within the physiological capacity of those who are to use them. In many cases elaborate measures must be devised to extend the limits of normal human functions. To endure extremes of temperature or to protect against them; to ensure co-ordination of the sensations and reactions in the atmospheric conditions of high altitudes and at great depths; to perfect the adaptation of vision to dim light; to control, or sometimes for offensive purposes to enhance, the means of illumination and dazzle; to protect against, and incidentally to find means to evade the possibility of protection against, flame as a weapon of offence; to perfect the means of audible communication amidst external din; to concentrate nourishment in palatable form within restricted limits of weight; to find means of minimizing the effects of rapid acceleration and deceleration of the body, and of the motions which produce sea and air sickness. These and many similar tasks called urgently for further consideration by several committees of the Medical Research Council in Britain at the outbreak of war, and concurrently with the rapid development of the machines have demanded continuing intensive research. The Russians have, so far, not emulated our other Allies in pooling the results of their researches; but it is certain from the success that has attended their corresponding weapons in the field, and indeed their whole military effort, that they have solved the problems which have beset us. Like ourselves, they have mobilized the resources of their physiological, pathological and other research departments to promote the efficiency of their military forces.

The Russian is a man with a realistic sense of the main chance, and the Soviet military surgeon, like others, believes in prevention at all costs. Thus it is that the Russian soldier of the Red Army finds himself better prepared to face the rigours of winter than his counterpart in the vaunted German military machine. If one sees, as one may, ill-shod folk in the streets of Moscow, it is because the soldier must have the best footwear if he is to sustain, in wet, cold and rough going, the sternest tests. No civilian in Russia grudges sacrifice or discomfort or hardship that is the outcome of the soldier's necessity. The Red Army is the darling of the nation. The people have unshakable confidence in it. It is perhaps the knowledge of the implicit trust reposed in them by their own people that inspires the Soviet soldier to such heroic deeds, to such wonderful feats of endurance. To have created such morale in people and army alike is one of the major achievements of Marshal Stalin and those who serve him.

Of the actual achievements of the Red Army doctors we shall not know in full until years after the War, when medical history is written. All I can do is describe what we of the Surgical Mission saw and did not see (though we looked for it), in our carefully conducted visit to the Red Army. In the South African Campaign I was plunged into a devastating epidemic of typhoid fever at its height. I know what it does to an army and the strain it puts upon the medical corps. In the War of 1914–18 I learned what a very different picture is presented at an advanced C.C.S. when wounded men are streaming in from victory or dragging wearily back from unsuccessful fighting. In this War it has been my rather tragic duty to witness in most of the heavily attacked cities the effect of bombing on civilians of all classes. I have been privileged to see and hear a good deal of the most modern accomplishments of our own and our Allies in war surgery and medicine. My companions on the Mission were men of similar experience and knew what to look for. With that background, then, what did the Russian picture reveal?

A first estimate of the achievements of military medicine in the U.S.S.R. may be deduced from the fact that the Red Armies are still in the field and victorious after retreats of depressing magnitude. There are authenticated examples in history of the collapse of good troops in the face of epidemic sickness and mass casualties, simply and solely because of the absence of a competent medical personnel. It is certain that the Russian soldier must have been well cared for; it is certain that the organization and the standard of service we witnessed must have extended, if not quite at the level chosen for demonstration to foreigners, yet at approximately that level along all the fronts, and throughout the territory to which troops found their way.

The People's Commissar of Health claimed that the U.S.S.R. have practically abolished two of the greatest scourges of armies in the field: one universal on modern battlefields—gas-gangrene—and the other, formerly endemic in a great part of the territory over which their fighting spreads—typhus fever. He told us that since the fighting began there has been no

* Substance of a Friday evening discourse at the Royal Institution delivered on February 25.

cholera. He also claimed that they get 70 per cent of their wounded back into the firing line—a figure not reached elsewhere. Probably we get between 60 and 70 per cent back into service, but not all of them into the front line. How have these feats been accomplished ?

I am not prepared to admit as yet that either typhus or gas-gangrene has been entirely prevented, or treated with such uniform success as might appear from the claims put forward ; but undoubtedly the Russians have controlled typhus epidemics where they might have devastated an army ; and they acknowledge the same methods we ourselves employ in the mitigation of gas-gangrene. It may be that they have other and better methods than those disclosed ; but so far, the allied medical corps are unaware of them, or of documented reports that justify confidence in their existence. On the other hand, the traditions of Russian research are so great, and the devotion of the Soviet authorities to-day to research in every field so intense, that there is nothing inherently improbable in a claim which perhaps can only be publicly substantiated after the War.

In connexion with those research traditions, one may consider three names, those of Mendeléeff, Metchnikoff and Pavlov. First. that of Mendeléeff, upon whose fundamental work much of modern chemistry rests ; remotely, but veritably, he laid foundations upon which modern biochemistry has been built, with all that the sulphonamide drugs have accomplished by way of lessening the horrors and the tragedies of the battlefields. It is not such a far cry from the recognition of atomic numbers and the Periodic Law to the production to-day by the ultrasonic generator of microcrystals no more than eight times the size of a red blood corpuscle by Prof. Paramanov. Nor to the fabrication of emulsions by Prof. Lossovsky, which, by the aid of chemical stabilizers, gradually dispense with more and more oil until they are almost wholly aqueous. Both these methods permit safer use of sulphonamides intravenously ; indeed, in one respect they have gone farther than we—injection into the arterial as well as the venous stream. This is the appropriate place to mention penicillin. The Russians having hitherto scarcely any supply, though our Mission took a small quantity, Prof. H. W. Florey has been sent to Moscow with a considerable quantity of the drug and all his knowledge. That is one of the gestures made by the British and American Governments to convince the Russians we are ready to put all our resources, all our discoveries in any science, at their disposal. Of course, we should welcome reciprocal trust.

Metchnikoff, who worked largely in Paris, made great contributions both to bacteriology and to the understanding of the natural defences of the body against infection, which we now exploit by every means that can be devised. It is in the tradition of his work that the attention of Russian research should be directed not only to the control of infecting organisms by bacteriophages and bacteriostatic agents, but also to new methods of stimulating the defensive mechanism. For that purpose they are exploiting 'activators' of various kinds. Prof. Bogomouletz produces sera by injection into horses of splenic and lymphatic tissue, and finds that their action upon mesoblastic structures, particularly the vascular network, materially stimulates repair. They use the sera to promote healing of gastric ulcers and also to diminish the period of repair of wounds. They claim something like a 20 per cent reduction of invalidity-time in cases of fractures and gross soft-part wounds.

They have other methods of producing the same effect, by burying under the skin partially ischæmic cutaneous flaps or placental tissue prepared by a chemical treatment. Extracts of placental tissue are also employed to hasten the 'taking' and the growth of skin-grafts. We saw these methods in use in the wards of Profs. Louria and Friedland.

Pavlov, whose contributions to physiological psychology introduced the element of measurement and exact observation necessary for all scientific advances, clarified a wide field of mental processes ; he trained a school of Russian psychologists whose labours in their turn have been fully employed by the Red Army medical authorities in the training, conservation and care of their man-power. One example from their system of rehabilitation of the lightly wounded soldier struck me forcibly. These men go to special hospitals where curative measures, both operative and physiotherapeutic, are employed. There, 'education' accompanies their progress and serves a twofold purpose. A man may return to his regiment fully restored to his former vigour ; but he rejoins men who have had further experience that he has not shared. To that extent he is at a disadvantage and his sense of this particular inferiority may be deflected to the past disability, which he had far better forget. The Russians, therefore, see to it that his rehabilitation education shall make him more expert than ever in the use of his weapons ; better acquainted with the enemy methods and weapons he has to meet, and familiar particularly with the latest type of offensive machines of all kinds, and with the drill necessary for their most effective use. He then goes to his regiment with something his comrades do not possess, the last word in means for defeating and destroying the enemy ; he has at least one source of superiority and his morale is that much heightened.

Even to so elementary a medical requisite as cleanliness, the Russians add a psychological twist. Wounded men come in extremely dirty and often with several days' growth of beard. So, upon entry to the reception ward they find a 'barber'—not an orderly turned hair-cutter but a professional *coiffeur* who shaves them skilfully, cuts and shampoos the hair and starts the sequence which restores a man's self-respect. Thence they pass, after a drink of vodka, to the care of nurses, who bathe those who cannot manage for themselves—they have a real nursery 'tub'—and provide them with a clean set of underclothes or pyjamas. Only then, when they feel respectable again, does examination, sorting, dressing, begin. The cleanliness and warmth go some way towards 'resuscitation' of cases suffering largely from the fatigue, exposure and thirst which account for a good deal of the minor degree of shock. Of course, some cases are far too seriously ill to undergo this whole process ; but wounds as such are no bar, for they are covered with waterproof bags or 'jackets', and in the case of broken legs the patient is put upon a slatted wooden stretcher before immersion and the limb can be completely steadied by ties to the slats. A good wash restores morale. These examples, trivial as they are, illustrate the realistic attitude of the Russians and the intelligence with which their problems are attacked. Their psychology, theoretical and applied, is far from being at fault. Perhaps the success of their propaganda has prepared us for appreciation of their psychological methods with the soldier.

In my youth there was a famous book (Hilton on "Rest and Pain"), the theme of which was advocacy of immobilization; it held sway and governed practice for a generation. "Rest must be secured if pain is to be abolished." The pendulum of opinion swung and the supreme importance of early movement after injury was taught by the foremost surgeons of the day. We all know rather more precisely now when to employ rest and when movement.

In the recent Spanish War, a very well-known surgeon of Barcelona, Trueta—happily and fruitfully working among us now—advocated the treatment of gross injuries of the limbs, and especially fractures, by so close an application of plaster-of-Paris cases that all movement of the muscles of the limb was inhibited. Called the 'skin-tight plaster', it fitted like a glove. He advocated and secured 'rest', and the immobility of the muscles was so perfect that the pumping action which they normally exert upon the veins and lymphatics was abolished, and thus poisonous substances fabricated in the wounds failed to reach the general circulation, where their toxic effects would endanger the life of the patient. The principle is one which makes imperative meticulous observation of certain essential preliminaries in the way of operation and treatment; but in appropriate circumstances, the method is now very widely used in the Allied Armies and probably in those of the Axis, too. There was an earlier protagonist of a form of this expedient, an American, Winnett-Orr, to whom surgery owes very much, but the actual initiator of the close-plaster was a Russian. Pirogoff, whose name is known to every British medical student as the originator of a particular type of amputation which bears his name in our text-books, has been described as the "greatest Russian surgeon, and one of the greatest of all military surgeons". He used plaster-of-Paris for fractures in the Crimean War. He had noticed the use of plaster by a sculptor and realized at once how it could be adapted to war injuries. He wrote repeatedly on the subject, but years later lamented that neither French nor Italian military surgeons knew of his method.

Pirogoff's contributions to surgery were many. One more may be mentioned. Perhaps only after hearing of Florence Nightingale, but at any rate, in the Crimean campaign, with the help of one of the Grand Duchesses, he introduced nurses into military hospitals of the Russian Army.

Nursing means rather more in Russia at war than it does with us. Not more than our nurses would certainly volunteer to do did the necessity arise; scarcely more than they were ready to do in North Africa; but the position of women is a little different in the Soviet State in peace as well as in war. It is, I think, fair to say that the concession to women in the U.S.S.R. of exactly the same 'rights' as men has led to the full acceptance by them of their implied duties. Nurses go not only to the front-line hospitals, but also up to main dressing stations and into the line itself. They reach wounded men under fire, and drag or carry them to safety, and even if need be, defend their patients from enemy attack.

On our way to the front we found all the main road-crossings guarded by women soldiers carrying tommy-guns, and it was obvious that they would not have stood upon ceremony if our cars had not promptly obeyed the 'halt'! We did not, at the clearing hospital, see any armed nurses, but many women have been decorated for feats of bravery.

Of the versatility of the Russian nurses we had evidence enough. The story of their prowess with the axe, saw, plane and spade is now well known, and we witnessed it. The 2,000-bedded hospital in the pine-forest had at the time of our visit only about 700 patients, but the Orel advance was about to begin and expansion to 4,000-bed capacity was under way. The nurses not needed for their professional work were taking a full share in all the labours of construction, foundation digging, timber squaring, carpentry, camouflage and decoration. Very deft with their tools they seemed to be. It must not be forgotten that for our entertainment that evening those same women staged a very good cabaret show.

To judge of their proficiency in their proper sphere we had opportunity in operating theatres. It was manifest that the standard of the theatre sisters and their staffs was very high. As surgeons we felt that we should confidently work in theatres run by those women. In no hospital that we visited did we observe evidence of poor ward-work. Their bedsteads and mattresses are not so good as ours, and that makes nursing more exacting; demands more conscientious attention to detailed care; and I think we are entitled to infer that nursing is well done.

Organization is a strong point in the Russian of to-day. The basic plan of military hospitals is flexible; they are planned in units which may be grouped or detached at will; the staffing is so systematized that a unit sent forward from a base hospital can take over the whole or a section of a forward post. They have aimed at 'leap-frogging' as a means of maintaining continuous service in advance or in retreat, so that the supreme requirement of getting the wounded early to operation can be fulfilled in all circumstances. In our own North African war, with characteristic capacity for putting a telescope to a blind eye, the British overlooked the rules laid down in the manuals and improvised just such a leap-frogging plan—section by section—to the great betterment of a threatening situation. Necessity, with us, mothered invention; the Russians planned it in advance. Moreover, they have so arranged the segregation of all regional wounds in their forward clearing hospitals, into the care of front detachments of the staff of their head, chest, abdominal, plastic and orthopædic hospitals, that the patients fall at the earliest moment into the hands of those who will initiate specialist treatment. The same 'teams' will have members away in the far rear, to whom long-stay cases are sent, and thus the whole course of a soldier's invalidity can be controlled and studied by the same specialist staff. There is no doubt that such a system, if the nature of the warfare permits its adoption, is the best devised for saving not so much the life as the full function of the wounded. This, perhaps, is one of the means by which they secure so high a percentage of return to full duty. By contrast with the Soviet success in this respect, one may compare the results on the same ground a century and more ago.

In Napoleon's campaign of 1813, out of 22,000 French soldiers admitted to certain hospitals during May 1–June 1, 6,700 officers and men were known to have returned to active service in their units: just over 30 per cent. Another 20 per cent were capable of some duty; the total figures may have been higher in both categories, but certainly did not approach the modern Russian claim. Moreover, there were 972 amputations in that one month—tragic testimony to the prevalence of gangrene. 2,400 died, that is, more than 10 per cent of those reaching base hospitals.

These French figures were given by the great military surgeon Larrey, of whom Napoleon said, on leaving him 100,000 francs, that he was the most virtuous man he had known. Of cases reaching our own base hospitals in some recent actions, the deaths were little more than 1 or at most 2 per cent.

I have sat at a table in a clearing hospital behind the front with a woman surgeon wearing five wound stripes, and in the same hospital saw a woman operating on chest cases, of which she had done more than a thousand. Many women doctors have been decorated for bravery. It is perhaps of interest to mention that whereas in peace 50 per cent of medical students are women, now in war they number 85–90 per cent of the 24,000 a year being trained. 16,000 young military doctors, of both sexes, were given special courses in military medicine in 1942.

Another test of efficiency that may be applied is the recognition of problems of major importance in modern military experience. One of the most valuable of all modern methods for saving the life of the wounded soldier is blood transfusion, and here the Russians have been no whit behind us. Their methods for the collection, preservation and distribution of whole blood, their preparation of dried blood constituents for reconstruction in the field, and their many plasma substitutes, indicate very clearly how early and how thoroughly they were seized of the immense life-saving value of this means for controlling 'shock'. A minor measure reveals their appreciation of a psychological factor. The blood is mainly given by women —95 per cent of it, we were told. To the ampoule of blood the name of the girl donor is attached. She knows the wounded Red Army man will hear of her. He knows to whom he is indebted. Romances result and are broadcast for their full propaganda worth. The man who has once benefited, if he be wounded again, asks for the same life-giving blood once more. Blood donors in Great Britain may be interested to know that after tests, and on arrival at the taking station, all women are clothed in sterile garments, caps and masks, before admission to one of the four theatres kept for the four blood groups. They are given a light meal, without fats, just before the blood is drawn. In another station the donor does not enter the theatre at all, but lies upon a couch and thrusts her cleansed arm through a sterilely curtained window into the room where the blood is taken. The arrangements are on a vast scale and thought out to the last detail. As many as eight hundred donors are bled daily in one institute. The headquarters of the Blood Transfusion Service has seventy-nine subsidiary institutes under its control, with 1,500 minor stations. Preservation of the blood calls for methods adapted both to the duration required and to the means of transport. When taken by air at high altitudes or in the very low temperatures of winter, special insulating boxes must be used. Distribution is generally by air.

As to other pressing problems, we were fortunate enough to obtain first-hand evidence from distinguished research workers. The Academicians Orbeli and Lena Stern, whose studies have for long been devoted to the elucidation of the functions of the autonomic nervous system, are probably responsible for the orientation of Soviet thought towards neural rather than biochemical predominance in normal and disturbed metabolic functions.

The former, Orbeli, has among other applications of his research, turned to advantage his long studies of the phylogenesis of parts of the nervous system in relation to dark-adaptation of the eye, especially for night-pilots, using his differential study of the rods and cones, and of the Purkinje effect, to that end.

Lena Stern, the only woman Academician, has tackled a problem that still eludes complete solution. It is recognized that in some cases of what we loosely term 'shock', a phase is reached when no amount or kind of transfusion is effective. The dynamics of the circulation have been disturbed to a degree which is 'irreversible'. It is a stage desperate as regards the patient's recovery, and justifies desperate remedy. Stern believes that the 'irreversibility' is dependent upon a complete loss of tone of the musculature of the whole vascular system. She believes that tone is ultimately controlled by centres bordering upon the cerebral ventricles; probably the fourth ventricle particularly. Potassium stimulates the sympathetic and calcium the parasympathetic. She therefore forcibly injects into the cisterna magna, and believes that she thus directs into the ventricle a sterile solution of potassium phosphate; the potassium for its direct effect, the phosphate radical to form, with calcium already present, a non-ionizable and inert compound. An injection into the cisterna magna, except in very expert hands, and in conditions giving guarantees against infection, is not a method to be lightly employed. The syndrome it is sought to remedy is met with within a matter of hours after wounding and exposure; met with, therefore, most frequently before the victim arrives at a well-stabilized hospital, and the remedy must be chiefly useful, at any rate until its value is very thoroughly established, in the hands of experts who reach the forward positions. Prof. Stern stated that a considerable number of reports of success with her method had reached her, but among Russian surgeons generally its use, we gathered, is regarded as experimental. Incidentally, Prof. Stern told us that she had had success with the treatment of tetanus by the cisternal route. In man many severe cases had been cured, and in horses there was a 100 per cent recovery.

As with the Russians, so among the other Allies, the factor of fluid loss in shock has been in the foreground of the picture, but in recent years there have been periods when the neurogenic factor has been enthusiastically pursued here; its importance, however, has never gained unquestioned credence. The 'toxic' factor, to the importance of which Sir Henry Dale directed attention twenty-five years ago, and to the investigation of which his researches lent such impetus, has again come right into the foreground and is engaging a great deal of attention. The Russians have not entirely overlooked this possibility.

We were interested in one method of treatment which runs contrary to all past experience, ours and their own, for frost-bite. It has been the universal practice, of mountaineers as well as soldiers, to avoid rapid warming of parts involved. To rub gently with snow; to warm the rest of the body, perhaps, but to keep the frozen or menaced areas cool. The Russians now put the patients into a well-warmed ward and deliberately heat the frost-bitten limb. They believe in early excision of dead tissue, and, we gathered, in early amputation, and that may possibly be part of the explanation: they cut their losses. But they maintain that their method has a sound physiological basis.

In 1812 Larrey said that the hospitals of Moscow, both military and civil, were the finest he had ever seen. That could not be said to-day of those we saw. The

buildings are not recent. It is an item to which the Soviet has not yet fully turned its planning attention. When it does so, it is certain that the structures will be determined by function and leave nothing unfit for comparison with the best of other countries. The scale upon which the Russians think is illustrated by their projected great Research Institute, V.I.E.M. It was intended at first to erect it in Leningrad, but afterwards Moscow was decided upon. The plans are, as they themselves say, grandiose. With only five hundred beds for the intensive study of normal health and somatic disease, they provide approximately a hundred sets of laboratories or departments and 1,300 workers as a beginning. Since every medical student proceeding to an M.D. must present the results of research, which with clinical work normally spreads over six years, the laboratory space, technicians and directors of research must be provided on a great scale. A Red Army convalescent home provides another example of the scope of Russian planning.

When it comes to military hospitals in the forward zone, we were witnesses of their skill in construction, their admirable camouflage, their adaptability and the excellence of their improvisation. It was in a pine forest just beyond Vyasma that we found the clearing hospital already mentioned. We came upon it without realizing that any building, let alone a great hospital, was anywhere near. They also have tented hospitals in the forests—of two hundred bed capacity for each of their specialist departments. Camouflage is essential, since on the Russian fronts the German does not observe the Geneva Convention. It entails two hardships upon the wounded even if the hospitals are not attacked. Smoke must not rise to give away a position and that makes contention with winter cold very difficult. There must be no metalled road running to the site, or the first reconnaissance plane will detect something to be attacked. This means a very uncomfortable and sometimes agonizing ambulance ride over the last mile of track.

We came in contact here with the partisans and guerrillas, who when wounded were regularly fetched in from their concealed collecting points by air. So complete is the organization that dentistry for those behind the German lines seemed quite a natural provision ; they make the denture in Moscow, to the mould brought in by air, and fly it back forthwith. The dental department of the Red Army has made enormous numbers of dentures for the troops on every front. In that attached to one facio-maxillary unit we visited, more than a million dentures had been made for soldiers. Artificial limbs, too, are made on a scale commensurate with the size of the armies. Those we saw were entirely constructed of wood, and to our thinking a little on the heavy side, but mechanically good.

No account of medical service in war would be complete without reference to the preparations for dealing with casualties in bombed cities. It is true that we have no towns comparable for utter destruction with Stalingrad and Vyasma, to mention only two that we saw for ourselves, though there are so many others in like plight. But in Moscow there is, judging by experience in Great Britain, little sign of bombardment, and the civil defence arrangements are not so much in evidence. We saw one control room, which had been used for bomb casualties, but it existed in peace, and enables every accident or acute emergency in Moscow to be brought to the great emergency hospital or to one of its six satellites. We watched three calls. From the receipt of the message to the dispatch of an ambulance with nurse and doctor aboard, the average time was one minute forty seconds. It would be difficult to better such a system, but I must add that with our own bitter experience in mind, I was disappointed to be told they had no organized messenger service to replace the telephones when an unlucky or well-directed bomb fell upon the exchange. I have no doubt that had the need arisen in Moscow a service would immediately have been improvised, and I expect Leningrad would tell a different tale.

Among the men responsible for Soviet achievement in the section of their life under review there are three whom we met whose characters suggest the basic reason for success.

The director-general of the medical corps of all the Russian armies, Lieut.-General Smirnov, is a man of thirty-seven. He is a big, fair man whose face can be expressive of determination, of irony, of humour. It is stated that as a child and youth he had no education and was employed in labouring work. Between twenty and twenty-four he fitted himself to enter a medical school. He qualified at twenty-nine. In eight years his ability has raised him to the highest administrative post in the medical services, and we were informed by an Academician that, in addition, his purely professional attainments were held in high esteem by men of science and practitioners alike.

The chief consultant surgeon, Lieut.-General Burdenko, is a man whose energy has enabled him to triumph over a personal disaster to his health that would have ended the career of a lesser man. He has inspired in his pupils and his assistants an unassailable devotion. It is evident that his opinion has moulded current military medical thought and practice. His own particular interest has been neuro-surgery, and it is to him that is owing the very active research in that department now so fruitful in Russia. He told us with pride that from front line to far base he had seven thousand beds for neuro-surgery, and we had evidence from Profs. Rappaport, Propper-Grashenko and Schlikov of the intensive study devoted to the occupants of his wards. Operative surgery on the central and peripheral nervous systems as we saw it practised is perhaps lacking in the refinements now the rule in American and British units, but the neuro-surgeons with us recognized that some of the records made at the front were as good as any they had ever seen, and they felt that the skill and ability were not lacking in the young men to permit their quickly reaching the highest proficiency.

In Prof. Yudin, head of the famous Sklissosovsky Hospital for accidents and acute emergencies in Moscow, Russia has an abdominal surgeon who would lend distinction to any clinic in the world. His experience is immense ; in some respects unique. His courage is matched by his gentleness ; his skill by his untiring devotion. It is characteristic that in war he should go often to the front and there devote his abilities to perfecting and teaching others the technique by which that most disabling of curable wounds, compound fracture of the femur, can best be treated. Watching this man at work, studying the conditions of work he has created about him to ensure success, seeing the subjects of his most daring and extensive operations a week after operation, we could not but feel that the service which has such a man, nay, such men, has a source of inspiration

which has carried it far, and will lead it to great heights.

Russian military medical officers have maintained their armies in the field without the occurrence of any epidemic disaster; they have enabled their soldiers successfully to use the most powerful and elaborate of war machines; they have cared for the wounded so skilfully as to obtain a record recovery-rate; and they have sustained the morale of their troops through a period of devastating tribulation to the dawn of a triumphant advance.

What more could be asked of the army medical corps of any nation?

INTER-RELATIONS OF PLANTS AND INSECTS

IN opening a joint discussion on "The Inter-relations of Plants and Insects: the Place of Both in the Eco-system" between the British Ecological Society and the Royal Entomological Society of London held on November 12, Prof. E. J. Salisbury claimed that though the insect – flower relations have been extensively studied, the quantitative aspects of insect-pollination have been little explored though economically important, while the competition aspect has been largely ignored. The elaborate and familiar relation between the yucca moth Pronuba and *Yucca filamentosa*, in which the reproduction of each is dependent on the other, but the larvæ take a high percentage of potential ovule production, serves to illustrate how narrow may be the margin between benefit and disadvantage in the relations between insects and plants.

The relations of insects to plants as pests or predators set many questions that require answers. Why, for example, are some insects almost omnivorous, whereas others are confined to particular species? Familiarity with human preferences obscures the fundamental problems waiting to be investigated. Something of the complexity of the problem is indicated by insect larvæ which in the wild state are found on one food-plant only but in captivity can be reared on a variety of species. An analysis of the physiological basis for such preferences might well yield data of great practical importance in the field of horticulture and agriculture. Whether a plant species in the British Isles supports the same insect population as the same kind of plant in continental Europe is also a matter of great biological interest. For the nature and variety of the insect predators and pests to which a plant species in Britain is subject may be an important indication as to the length of time that the plant has been present in these islands or, on the other hand, as to the efficiency of insect dispersal.

The influence of man has created in the past, and is constantly creating in the present, habitat conditions where the pressure of competition is reduced or even negligible, and the species associated with the arrested successions thus artificially maintained have been frequently regarded as under suspicion of being introductions. But the species which to-day we find most frequently occurring in, or even confined to, artificial conditions, may be those which in former times were to be met with in similar though much less frequent conditions created by natural agencies. On the other hand, they may represent what may be termed domestic species which have arisen since the widespread occurrence of such habitats, and in some instances may have extended into natural habitats of a similar character. This might appear to have little concern with the relations between plants and insects were it not that both groups of organisms present the same general problem, and an intensive study from this point of view of such very interesting series as that presented by the group of house spiders and their allies might well shed light on the fundamental problem. The domesticated flora and fauna not only deserve more attention than they have hitherto received, but also attention to the relations of both might reveal what the study of either alone could not achieve.

Dr. E. A. Cockayne discussed a number of Macrolepidoptera which are limited by special plant species. Many species of moth are attached to a genus rather than to a species, and others eat two or three plants belonging to allied genera, such as Fraxinus and Ligustrum, Calluna and Erica, Urtica and Humulus, *Silene maritima* and Spergularia. Oak has more species of Macrolepidoptera restricted to it than any other plant; they are eighteen in number and belong to several families. In the case of many larvæ limited to a single plant species, the latter is the only representative of the genus found in Great Britain, but on the Continent, where other members of the genus occur, these also are eaten; for example, *Bupalus piniaria* is confined to *Pinus sylvestris* in Britain, but eats other species of Pinus on the Continent. Other examples of genera with only one native species are Fagus with one species of moth restricted to it; Alnus with two; Clematis with five; Euphrasia with two; Eupatorium with one; Serratula with one; Solidago with two; Phragmites with nine; Elymus with one; Ammophila with one. On the other hand, *Ulmus campestris* has two species peculiar to it and *Ulmus montana* has two others; *Carex glauca* has one; *Calamagrostis epigeios* has two; *Festuca arundinacea* has one; *Deschampsia cæspitosa* has one; *Artemisia absynthium* has one, and *A. maritima* has two; *Lysimachia vulgaris* has one, and *Convolvulus arvensis* has three. In such cases the selection of one species of a genus is usually due to a difference in ecological conditions.

It is interesting that most British moths with a very restricted range are not restricted because of the absence of a special food-plant. *Anepia irregularis*, however, has the same narrow range on the Breck sand as its food-plant, *Silene otites*, and it is probable that the limited south-western range of *Drepana harpagula* is coterminous with that of *Tilia parvifolia*.

Some British Lepidoptera have reached the northern or western extremity of their distribution and have become limited to special ecological conditions or to a special food-plant. *Papilio machaon* is found only in the Fens, and feeds chiefly on *Peucedanum palustre*; while abroad it is found in all kinds of country and feeds on many umbellifers; *Malacosoma castrensis*, an inland and woodland species on the Continent, is only found in the salt-marshes of south-eastern England, though it feeds on most of the plants which grow there. *Brachionycha nubeculosa*, which feeds on many kinds of tree abroad, only eats *Betula alba* in its local haunts in the Highlands of Scotland.

There are instances of biological races with different food-plants. *Eupithecia denotata* eats the seeds of *Campanula trachelium*, and its race *E. jasioneata* eats those of *Jasione montana*, while *Hydrelia flammeolaria* eats maple in the south and alder and mountain ash

in Scotland. The distribution of the two plants might explain the former case, though it is not clear why other species of Campanula are avoided; but there is no obvious reason for the different food-plants of the Hydrelia in the south and in the north. *Plemyria bicolorata* eats rose, blackthorn, crab apple, birch and alder in England, but in Dr. Cockayne's experience, only alder in the north of Scotland.

Captain C. Diver spoke of insects limited by the general conditions imposed by plant communities. The good field naturalist undoubtedly knows where and when to look for the species in which he is interested. This apparently intuitive recognition is the subconscious crystallization of innumerable small impressions and experiences revealed by his acute powers of observation and slowly built up by his memory into a complete picture. Knowledge of this kind is fundamental to a clear understanding of some of the major problems of biology, whether pure or applied. No progress can be made in the study of animal and plant populations, distribution, colonization, plagues, the control of pests, and so on, until we can give a proper answer to the question why this place is 'right' and that place is 'wrong'.

After giving examples of the simpler aspects of this problem from among Lepidoptera, Odonata and other groups, Capt. Diver went on to consider two genera of hover flies investigated at Studland Heath in Dorset. There occur at Studland seven out of the nine British Helophilus and ten out of the eleven Eristalis. The larvæ of both these genera can be stated broadly to live in stagnant wet conditions; but the adults require additional amenities which are not all present in the places where the larvæ can live; and if these are not represented in neighbouring habitats, places where the larvæ could live are not likely to be occupied by permanent populations.

The adult Helophilus generally stays closer to the larval habitat than does the adult Eristalis; but it requires the structure of the vegetation to be such that this provides sheltered flying places, and preferably a fair supply of flowers to visit. Helophilus will not normally be found hovering or laying in the type of marsh where the vegetation over a large area is uniformly short, which means that there is no shelter from wind at heights above a few inches from ground level. What these flies seem to like is an uneven structure giving a good mosaic of patches of short and tall vegetation, the air above the former being protected by the wind-breaks made by the latter. It does not appear to be so important which plant species are present as that some should be tall and some short; although a good flowering population of *Potentilla palustris* Scop. is an added attraction for the less adventurous species, provided it is growing in a sunny and reasonably sheltered spot.

The species of Eristalis vary more widely in their needs; though most species are inveterate flower visitors, and the commoner ones are on the wing from the flowering of the sallow to the flowering of the ivy. But they need also the right conditions for hovering. *E. aeneus* Scop. and *E. sepulchralis* Linn. can tolerate the low vegetation and exposed conditions of salt-marshes, where they hover close to the ground. *E. intricarius* Linn. tends to hover high, but does not apparently demand good wind-breaks. While *E. pertinax* Scop. and *E. tenax* Linn., which usually hover at heights between 4 ft. and 8 ft., seem to find their optimum for this exercise in sheltered woodland glades. The primary characteristic of a woodland glade for this purpose is precisely the same as that required by Helophilus in the marsh; that is, an area of relatively low vegetation surrounded and sheltered by taller species. But unless these glades are of sufficient size relative to the height of the trees so as to get full sunlight, they will not provide good conditions for these species. Eristalis seldom hovers in the dapple light under trees. These sites are occupied by other Syrphids, particularly the common *Syrphus ribesii* Linn. and *S. vitripennis* Meig.

The width, the complexity and the difficulties of the general problems raised by these few illustrations need no stressing; there is here an immense and fascinating field for careful observation and research. As a final plea, Capt. Diver urged that, though it is highly important to call a species by its right name according to the rules, it is even more important to know where and how that species lives, and why it chooses to live where it does.

Dr. C. F. C. Beeson dealt with the influence of insects on the regeneration, composition and destruction of forests. Virgin forests are characterized by freedom from insect epidemics, but catastrophes due to external factors may release destructive forces latent in endemic phytophagous insects. Seed insects are less important influences on the regeneration of forests than are insects feeding on the seedling and young sapling. The composition of a tree community is determined largely in early youth but may be modified later by insects. "Pure forests are more liable to outbreaks of insect pests than are mixed forests" is an axiom of forestry. Virgin tree-associations, which are immune, are protected by components of the field stratum. Mixed forests derive immunity from complex interactions based on structural and floristic characters. The composition of a mixture from the aspect of crop protection can be defined in terms of its primary and subsidiary insect communities.

In the subsequent discussion, Dr. H. Godwin, president of the British Ecological Society, mentioned that the British Ecological Society has just begun publication of a "Biological Flora of the British Isles", which should prove of especial interest to entomologists.

Prof. P. A. Buxton directed attention to the interesting differential reaction of insects to associations of native and closely related exotic plants growing near together. He instanced the fact that the sawfly so familiar on *Iris pseudacorus* spreads to some cultivated Iris spp., but not by any means to all. Mr. B. D. W. Morley recounted similar observations made on *Aphis fabæ*, the usual winter hosts of which are *Euonymus europæus* and *Viburnum opulus*. The species has also been observed on some, but not all, foreign species of Euonymus growing in various nurseries and botanic gardens, and Mr. Morley suggested that physiological changes brought about by approaching leaf-fall may prove to be one of the factors affecting the choice of host-plant by the aphis. In this connexion Mr. A. J. Wilmott emphasized that very varied reasons may decide why a particular insect feeds on one or more species; even if Mr. Morley's explanation that leaf-fall is the decisive factor concerning *Aphis fabæ* be accepted, many other factors must also be operative.

Prof. Hale Carpenter asked how it is that bark beetles, normally attacking only unhealthy or dying trees, are able to become a pest to healthy trees. Do trees normally produce some deterrent preventing the spread of bark beetles, which the beetles by insistent attack in great numbers are able to overcome? Do

trees cease to produce a deterrent, or do the beetles become by degrees less affected by constant exposure to it? Dr. C. F. C. Beeson replied that trees certainly do react to these attacks, but not to such an extent as to be able to control large-scale attacks.

Dr. W. H. Thorpe referred to the probable influence of parasites in reducing or eliminating a polyphagous host species on certain of its food-plants. In this connexion he directed attention to the desirability of placing on record, with as much detail as possible, particulars of differences in percentage parasitism associated with different food-plants. Dr. B. Barnes remarked that just as related species of insects attack members of Rosaceæ and Salicaceæ, so do related species of fungi; he stressed the need for biochemical investigation.

Prof. H. G. Champion emphasized the point made by Dr. Beeson, that the influence of insect attack on the specific composition of vegetation is relatively greater in the earlier stages of plant colonization or succession, when the competition between species is most severe, and it may take very little to tilt the balance one way or the other.

On the more general aspects of the subject, Dr. G. C. Varley suggested that problems of numbers, or of animal or plant distribution, are insoluble until the fundamental problem of what factors control the population density of the species of plant or animal in the community have been solved. He believes that when ecology can go beyond the descriptive stage, and studies and analyses the problems numerically, a rapid advance will follow. Dr. B. P. Uvarov said that to him it was very significant that practically all speakers had concentrated their attention on problems of the individual ecology of species, or of groups of species, rather than on community ecology. The way of individual ecological studies may be a long and arduous one, but it is a very healthy symptom that British ecologists are deliberately choosing it instead of the easier, but barren, method of mass collecting, counting and statistical analysis of populations assumed to form communities.

OBITUARIES

Sir David Prain, C.M.G., C.I.E., F.R.S.

THE death of Lieut.-Colonel Sir David Prain on March 16 has removed from the botanical world a distinguished man of science and an endearing personality.

Born at Fettercairn, Kincardineshire, nearly eighty-seven years ago, Prain was a product of the period when recruits to the botanical ranks were mostly obtained from the medical profession. From Aberdeen Grammar School he passed to the University, where he graduated with honours in science, and after an interlude of two years teaching turned to medicine, for which he qualified with distinction in 1882. The two following years were occupied in the positions of demonstrator in anatomy at the Edinburgh College of Surgeons and then at the University of Aberdeen. In 1884 he entered the Indian Medical Service, where his botanical aptitude at once attracted attention, so that at the age of thirty he began an official botanical career as curator of the Herbarium at Calcutta and eight years later became professor of medical botany. Thus the earlier years of Prain's life were largely spent in the art of imparting knowledge to others, but with his appointment as director of the Botanical Survey of India and superintendent of the Calcutta Botanic Garden in 1898, Prain entered on the career of administration in which he achieved such conspicuous success. During this period he not only acquired a considerable knowledge of the Indian flora but also was instrumental in furthering the cultivation of species of medicinal value. In particular the cinchona production of India is almost wholly an outcome of his foresight and initiative.

When in 1903 Sir Francis Younghusband led the Sikkim-Tibet Boundary Commission, Prain accompanied it as botanist and, as a result, our then scanty knowledge of the flora of that area was greatly augmented.

Among the earliest of his more important scientific works was an account of the plants of Bengal which dealt with nearly three thousand species and provided descriptions of all the genera and keys to the individual species. A substantial monograph of the Indian species of Pedicularis, of which sixty-nine were then known, contained an analysis of their distribution, and this was also a feature of the comprehensive account of the genus Dioscorea in four folio volumes which he wrote with I. H. Burkill. His interest in regional botany was again seen in his "Vegetation of the Coco Group" (1891), "The Botany of the Laccadives" (1893), and the "Flora of the Sundribuns" (1893). To Prain also we owe the first authoritative monograph of the genus Meconopsis, which has gained in both botanical and horticultural interest with the passage of time. His contributions to botanical knowledge were recognized by his election in 1905 to the Royal Society, which he served as treasurer for ten years from 1919.

Prain's appointment as director of the Royal Botanic Gardens, Kew, in 1905 was the beginning of seventeen years of efficient control of an institution that had already become by its size, functions and importance the chief taxonomic centre of the British Empire, and where advice was sought on the widest range of botanical interests. Here the new director's many gifts found scope to the benefit of the Gardens themselves and to science in general. His winning and kindly personality coupled with a humour, no less real because it had a subtle Scots quality, endeared him to his colleagues, while even those who might not agree with him could not fail to respect an integrity that was always courteous and just. Many of his minutes, written as director, are models of lucidity and well-chosen phraseology which lost nothing of their trenchant forcefulness by reason of their meticulous correctitude.

No one was in greater demand as a president of societies or conferences, and as a chairman of difficult committees his qualities of sound judgment and firm tolerance were seen at their best. It would be tedious to enumerate the list of important offices he filled, but by reason of his long tenure mention may be made of his service for thirty-four years as chairman of the governors of the John Innes Horticultural Institution, for twenty-seven years as a Carnegie Trustee, and for twenty years as a trustee of the British Museum. He also served for many years as chairman of the Advisory Council for Plant and Animal Products of the Imperial Institute and was director of the Forest Products Research Board, not the least of the services he rendered to the progress of economic botany.

The later years of Prain's life were marred by increasing deafness and, although his mental alertness

was unimpaired, he felt keenly the sense of isolation which this engendered. The extent to which he prized personal contacts can be gauged from a passage in one of his letters, written in 1937: "the tragedy of age, and the only one that hurts is the loss of friends whom one has survived". We too have suffered the loss of a much-valued friend, and science one who served her well. E. J. Salisbury.

Flight-Lieut. J. A. Moy-Thomas

By the death, in a motor accident while on duty, on February 29, of Flight-Lieut. J. A. Moy-Thomas at the age of thirty-five, we have lost one of the most distinguished of the younger generation of zoologists. The study of fossil fishes attracted him most, and he made many valuable contributions to our knowledge of their structure and classification. Particularly did he devote himself to unravelling the difficult problem of the true affinities of certain well-known forms of very obscure relationship.

A pupil of Archer Vassal at Harrow School, he obtained a scholarship at Christ Church, and read honours in both zoology and geology at Oxford. His first published research was on the development and attachment of teeth in fishes (*Quart. J. Roy. Micro. Soc.*, 76; 1934). There followed a series of memoirs on Chondrenchelys, Pristychius, Petrodus and other early shark-like forms, many of which he had collected himself during his expeditions to Scotland and elsewhere. These researches threw much light on the evolution of the Selachii and Bradyodonti including Holocephali. Already, in 1934 (*Proc. Zool. Soc.*), he had pointed out the affinity that very aberrant Palæoniscid, called Tarrasius by Traquair, may have with the living Polypterus (of which he had published a description of the chondrocranium), and thence passed to the detailed study of Palæoniscids in another series of memoirs not yet completely published. In the course of this work he brought out several papers in collaboration with E. I. White, of the British Museum, and Miss Bradley Dyne. With the same admirable powers of observation and happy interpretation he next dealt with the Cœlacanths, and described those of Madagascar. In 1939 he joined an expedition to Greenland to collect material with his intimate friend Prof. E. A. Stensiö of Stockholm.

Particularly important and characteristic of his careful method of dealing with difficult material is Moy-Thomas's work on Palæospondylus, recently published (*Phil. Trans. Roy. Soc.*; 1940). This little fish from the Mid-Devonian of Scotland has been a puzzle to all observers since Traquair first described it in 1890 and assigned it to the Cyclostomes. This interpretation was generally accepted, though some believed it to be a larval form of some higher fish or even amphibian. Moy-Thomas, after examining a vast number of specimens, rejected the larval theory as inconsistent with the presence of well-formed vertebral centra and the condition of the elements of the skull, and also was unable to confirm the presence of many alleged Cyclostome characters. More important still, he discovered that the tail had hitherto been misinterpreted, had been described upside down, and was really heterocercal with a larger ventral lobe supported by jointed radials; he also provided good evidence of the presence of paired fins, and of jaws. Thus he seems to have established that Palæospondylus belongs to the Gnathostomes. Fortunately, the most important results of these various researches were embodied in his excellent little book on "Palæozoic Fishes" (1939), published just before the War.

Deeply interested in the comparison of the dermal bones of the skull in the various groups of Osteichthyes and Tetrapoda and the tracing of their homologies, Moy-Thomas was not content with mere observation and description, but tried by experimental methods practised on living forms to discover the causes which may influence their shape, size and number. Already in 1941 he had reached important results on the rainbow trout, and concluded that, contrary to earlier theories, the origin of such bones is not due to the presence of the sense organs of the lateral line system or of the central nervous system (Nature, May 31, 1941, p. 681).

Moy-Thomas began his teaching career under Prof. W. Garstang at Leeds, where he went soon after taking his degree. Returning to Oxford, he was made University demonstrator and lecturer in the Department of Zoology and Comparative Anatomy in 1933, and also became the first holder of the fellowship founded by the late E. T. Browne at the Queen's College.

Moy-Thomas's love of accuracy and his excellent memory made him a most successful teacher and tutor. But his influence on his pupils was not only academic. Possessed of great gaiety, sense of humour and zest of life, he was a continual source of stimulation and pleasure to everyone who knew him. With these attractive gifts he could make criticism, not only of their work but also of their life and manners, acceptable to his pupils.

Thus by this tragic accident has been cut short the life of one who will be much regretted by colleagues and many friends in Oxford and elsewhere. He leaves behind his wife and two children.

E. S. Goodrich.

Prof. H. Buisson

Henri Buisson, professeur de physique générale à l'Université de Marseille, est mort le 6 Janvier 1944 à l'âge de 70 ans, après une courte maladie. Il s'était fait connaître par de nombreux travaux sur l'optique, souvent avec Charles Fabry (métrologie interférentielle, repères spectroscopiques formant le 'système international des longueurs d'onde', photométrie, 'équivalent mécanique de la lumière', etc.). Depuis 1912, il s'était consacré, avec Fabry, à l'étude de l'ozone atmosphérique, travail qui avait été l'origine de nombreuses recherches, principalement en France (Cabannes, Dufay, Gauzit, Chalonge, Vassy, etc.) et en Angleterre (Dobson et ses collaborateurs).

Ch. Fabry.

The work of MM. Fabry and Buisson on atmospheric ozone was the foundation of all later work on the subject. It had been suggested that the remarkably sudden 'cut off' of the solar spectrum at about 3000 A. was due to absorption in the earth's atmosphere. To test this hypothesis, they made careful measurements of the absorption by ozone of light of different wave-lengths in the laboratory and compared this with the extinction of sunlight passing through the atmosphere. From these measurements they were able to confirm the hypothesis, and also showed that the total amount of ozone in the atmosphere was equivalent to a layer of pure gas about 3 mm. thick.

In addition, Prof. Buisson made regular daily measurements of the amount of ozone in the atmosphere at Marseilles and also showed that the amount of ozone in surface air was relatively very small.

The importance of ozone in the upper atmosphere lies in the fact that, together with carbon dioxide and water vapour, it probably governs the radiative equilibrium temperature at great heights, and is largely responsible for the existence of the upper warm region at a height of 50–70 km., where the temperature is probably above that at ground-level. For these reasons the names of Fabry and Buisson are familiar to meteorologists the world over.

G. M. B. DOBSON.

Dr. E. Granichstadten

DR. E. GRANICHSTADTEN died at Edinburgh on January 5, 1944. He was one of Austria's most successful industrial chemists, possessing the rare ability both to make discoveries and to apply them; he was also a great benefactor to science. His most outstanding contribution to chemistry was the development of the catalytic hydrogenation of oils and fats which made margarine manufacture possible. Shortly after Sabatier and Senderens had demonstrated that unsaturated hydrocarbons in the gaseous phase could be hydrogenated in the presence of a nickel catalyst, Dr. Granichstadten began his experiments on the transformation of vegetable oils into edible fats. After many difficulties he finally succeeded by passing electrolytic hydrogen through the highly purified oils into which the catalyst had been introduced as a readily reducible nickel salt, a process which found wide industrial application in most European countries.

In later years Dr. Granichstadten founded and endowed a research institute at the Alpine spa Gastein with the view of putting the renowned effects of its radioactive springs on a scientific basis. Spectacular progress had been made by the time Austria was invaded. Within three days of the invasion, Dr. Granichstadten was forbidden to enter his own institute, and shortly afterwards he was driven from his native country. He found refuge at Edinburgh, where he was engaged in experiments on nutrition until his premature death.

M. F. PERUTZ.

WE regret to announce the following deaths:

Sir Charles Boys, F.R.S., on March 30, aged eighty-nine.

Sir Cecil Harcourt-Smith, K.C.V.O., formerly keeper of Greek and Roman Antiquities, British Museum, director of the British School at Athens during 1895–97, and director of the Victoria and Albert Museum during 1909–24, on March 27, aged eighty-four.

Sir Thomas Lyle, F.R.S., formerly professor of natural philosophy in the University of Melbourne, aged eighty-three.

Prof. L. R. Wilberforce, professor of physics in the University of Liverpool during 1900–35, on April 1, aged eighty-two.

NEWS and VIEWS

Parliamentary and Scientific Committee

THE annual report for 1943 of the Parliamentary and Scientific Committee refers to a substantial increase in membership. Subjects with which the Committee was concerned during the year included income tax and subscriptions to learned societies, coal utilization research, the training of Civil servants, scientific research and the universities in post-war Britain, on the last three of which reports have been issued, research and Colonial development and income tax and research expenditure, on which a memorandum has since been issued. Further action is projected in regard to the universities and research. A motion has been tabled by members of the Committee in the House of Commons which, it is hoped, may provide the opportunity for a debate during the current session, while a sub-committee has been set up to report on the general question of how research in Great Britain might be developed and organized in the most efficient manner. At the annual general meeting held on February 3, 1944, the chairman reported that it was hoped that the first report would cover a general introduction as to the principles which should be applied to the organization and development of all fields of research work and the development of industrial research. Further reports might concentrate on research and agriculture, research and housing, etc.

At the annual luncheon on the same day, Lord Samuel, after referring to the presence in the Government of four men who had undergone scientific training at the universities, suggested that the Lord President of the Privy Council should have his functions enlarged so that he might become the representative of science as such in the Cabinet and among the other Departments. Lord Woolton paid a warm tribute to the work of the Committee, emphasizing that it is by the application of scientific discovery to the ordinary everyday life of the people that we raise the standard of life of the whole community, and referring particularly to what had been done in recent years with regard to food. Sir Raymond Streat suggested that the immense enlargement of the areas of fundamental knowledge and the increasing tendency for society to demand from science the attainment of specific objectives are leading us into an age of applied research. To meet that challenge, we have not so much to extend the quality and volume of our scientific work as our organization to develop and apply it, and to evolve modifications of our social, political, economic and legislative framework so that we may absorb the impact of an era of research and increase the health and vigour of our society. In connexion with the last, British natural conservatism is our danger. To what extent are our ideas of social security, our instinctive reluctance to acknowledge obsolescence, our regard for property, our trade union practices, inimical to rapid absorption of the consequences of scientific progress? Every effort should be made to prepare the public for the pace at which society must absorb the fruits of scientific work.

The Airborne Surgical Unit

The limited but valuable experience which has been obtained of the feat of taking a surgical team into action with airborne troops is described by two R.A.M.C. surgeons who have organized it, Mr. C. J. Longland and Mr. L. Kessel (*The Lancet*, March 18, 1944, p. 381). Their article has been written "to correct the hyperbole and inaccuracy of accounts which have appeared in the lay press". Such surgical teams have been in action twice. On the first occasion it was proved that the feat could be done; the second job was a difficult one, but the team successfully established itself at night in a farm building behind the enemy's lines while a battle was going on near by. Some of the thirty-five operations performed were done $1\frac{1}{2}$ hours after the wounds were received, and four fifths of them were done within five hours of the wounding. The team consisted of a surgeon, an anæsthetist and five other ranks, one of whom was responsible for resuscitation and two were chosen for their nursing abilities. All were, however, trained in all phases of the work. The team also had field and parachute training.

The details given of the equipment taken will interest all who have to provide transportable surgical equipment for field purposes. It was found that a light operating table or stretchers and trestles can be carried. Anæsthetics, plaster, dressings and other expendable material were put up in packs suitable for ten cases. Other items were instruments, plasma for resuscitation, feeders, bowls, trays and other ward equipment, and a sterilizer and boiled water container into which some materials could be packed. Linen thread was the basic suture material, and acriflavine tablets were found to be the most economical and useful antiseptic. Primus stoves were found satisfactory for heating, provided that several were available; but it was "distressingly and effectively proved" that ether may be a dangerous cause of fire in a theatre heated by primus stoves. Out of 150 cases, only 11 needed any anæsthetic other than pentothal; the other anæsthetic used was chloroform. For lighting, the choice fell on paraffin pressure lamps and electric headlamps.

Apprentice Scholarship Scheme at Birmingham

In his annual report to the court of Governors of the University of Birmingham, the Vice-Chancellor (Dr. Raymond Priestley) comments on education for engineers. The University Joint Recruiting Board has been favourably impressed by engineering apprentices who have appeared before it for deferment or allocation in connexion with the Higher National Certificate in various branches of engineering. These men have entered industry either at or before the School Certificate stage, and have qualified, chiefly through evening work at technical colleges, to pass severe theoretical and practical tests. The successful candidates have impressed those whose duty it has been to interview them by their quality, grit and obvious sense of social responsibility. It has been quite clear that many of them are deserving of, and would be the better for, full-time university education, and that any university would benefit from their presence as students. Through conferences between the University of Birmingham, the Midland technical colleges and local firms, a scheme has been devised whereby the pick of the National Certificate holders in the Midlands might be admitted to the degree courses in mechanical and electrical engineering of the University. Candidates who have been three years in industry and who are nineteen years old or older will be able to matriculate through an examination towards which National Certificate subjects will count. A paper designed mainly to test ability for expression in English is the only additional obstacle to be surmounted. National Certificate scholarships with full maintenance, including residence at a hostel for the three years of the degree course, have been founded already by several firms.

Dr. Priestley points out that if the full value of the apprentice scholarship scheme is to be realized, it is essential that there should be the earliest possible modernization of the engineering equipment at the University of Birmingham. An appeal is therefore being made to the engineering industry of the nation, and particularly that part of it located in the Midlands, for a quarter of a million pounds for new buildings and equipment—a modest request for the Departments of Mechanical and Electrical Engineering. Close co-operation between the university and industry is necessary, and industry must accept the view that the university cannot by itself make practical engineers, production planners, and industrial managers. The university's primary aim must remain, on the research side, original contributions to the science of engineering; on the teaching side, the utmost possible development of the personality of students and a sound grounding in the sciences that underlie engineering and the basic principles of engineering science. What is needed is more and larger faculties of technology in the universities, possibly more universities, not hybrids in which applied science is developed to hypertrophy in dangerous isolation. The Manchester College of Technology is a good example of a well-developed faculty of technology in a university. We need also a more equitable division of Great Britain's intellectual *élite* among the universities.

Scientific Research and Development in India

In his opening address to the symposium on "Post-War Organisation of Scientific Research in India" held at Calcutta during September 27 and 28, 1943 (*Science and Culture*, 9, 135; October 1943), Sir J. C. Ghosh urged that the time is ripe for a critical examination of the facilities for scientific research and training that are available in India, and for drawing up plans for improving and co-ordinating such facilities. At present the agencies responsible for this work are the universities, the central institutes under the Government of India, the Imperial Council of Agricultural Research, the Indian Research Fund Association, the Board of Scientific and Industrial Research, the endowed research institutes like the Indian Institute of Science, the Indian Association for the Cultivation of Science, the Bose Research Institute, etc., and the research laboratories of industrial concerns like the Tata's. Sir J. C. Ghosh suggests an annual grant of Rs. 2.6 crores for research, and an equal grant for training research workers, as reasonable in the first three years after the War. With regard to organization, he suggests that the National Research Council of Canada rather than Russian methods may form the best model for India. Laboratories concerned mainly with short-range programmes of research should be administered by an all-India national research council through properly constituted research committees functioning on their governing bodies. With regard to develop-

ment work, he advocates the formation of a corporation of the type of Research Enterprises Ltd. managed by the National Research Council of Canada. Such a development corporation should be encouraged to take risks by an annual State grant, and introduce into industry and agriculture the inventions and processes worked out under the national research council.

New Light on the Inductive Method

EVERYONE who is interested in the foundations of scientific method will find it worth while to read the article entitled "Hr. Von Wright on the Logic of Induction" which appears in the issue of *Mind* of January 1944, from the pen of Prof. C. D. Broad. It is Prof. Broad's account of the attack on the problem of induction which Hr. Von Wright has made in his published works consisting of a thesis (in English) and an article (in Swedish) on logical subjects. Prof. Broad deserves our thanks for bringing the content of these two works to the attention of English logicians. This article not only presents a remarkable original contribution of the Swedish logician but also reveals Dr. Broad's own illuminating comments upon it. It is impossible to summarize the argument adequately in a few sentences. The article begins by pointing out that *where an unlimited sequence of instances is concerned,* the proposition "100% of the Q's are R's" does not entail the proposition "All the Q's are R's". The nucleus of the problem of induction is, "How can we pass from propositions of the former type based on a finite number of Q's to propositions of the latter type ?" The attempt to justify such a passage by *a priori* argument is neatly refuted by a proof both ingenious and conclusive. The attempt to justify it by arguments *a posteriori* leads to a discussion of how in practice the necessary and/or sufficient conditions of a phenomenon are established. The question then arises: "Can we infer with certainty by such means general propositions about the necessary or sufficient conditions of a given characteristic Q ?" The answer, very briefly, is: "Not without the help of postulates". These postulates are either *a priori* propositions, which is proved impossible, or inductive generalizations, which would lead to a vicious circle. Hence no justification of inductive generalization along these lines is possible.

Radio-Frequency Heating

AT an informal meeting of the Institution of Electrical Engineers held in London on January 24, the industrial applications of radio-frequency methods of heating were discussed, and the opening speaker was Mr. N. R. Bligh. The two main fields of application were eddy current heating and capacitance current heating. A third heating field was where the use of radio-frequency currents was only involved because such currents could be led into the charge through small capacitances; the actual heating process, however, was of the resistance heating class. The valve generator appears to be capable of generating all the power yet required for any application, even up to the highest frequencies of some hundreds of megacycles, and Mr. Bligh suggested that the only power rating which should be stated for a radio-frequency generator is its power output into its optimum resistance load, though for convenience the volt-ampere rating might also be given. The self-oscillator was regarded as the simplest form of generator, and up to a few hundred watts, glass envelope valves could be used, but beyond this external anode valves were preferable.

Regarding the load circuits proper, the charge is placed between condenser plates for capacitance current heating with one side of the load preferably at earth potential. In the case of eddy current heating the heating coil should be as tightly coupled to the charge as mechanical and electrical conditions allow. Applications of capacitance current heating are the completion of the dehydration of food, and the bonding of thin layers of thermoplastic materials such as vinyl resins and the cellulose esters. Eddy current heating has been used for some time in the production of thermionic valves, while the heat treating of surfaces and heating of very small items are becoming increasingly common.

Electricity Supply System Load Analysis

IN a paper read in London on March 16 before the Institution of Electrical Engineers by Mr. P. Schiller, an analysis is presented of the load on the system of the Northmet Power Co. during the year ended June 30, 1939. The block of annual load is split up into a basic or all-the-year-round portion, and a seasonal portion, the latter representing all the consumption due to space heating and about half that due to lighting. The basic portion is sub-divided into its principal components, and for the seasonal portion, an attempt is made to separate lighting load and space-heating load, in respect of both demand and annual consumption. Seasonal demand curves are developed, in which the load at a certain time of day is plotted for a series of days, and compared with the simultaneous conditions of outdoor temperature and illumination. The annual load factors of modern lighting and space-heating loads are found to be normally of equal order of magnitude; in a year with a cold snap the load factor of the latter may even be considerably lower than that of the former. Characteristic collective and component load curves are given, and graphs are presented dealing particularly with the space-heating load. The paper concludes with recommendations for further research.

Electrical Installation Equipment

A PAPER entitled "The Influence of Maintenance Requirements on the Design of Electrical Installation Equipment", read in London on March 9 by Mr. H. Drake before the Institution of Electrical Engineers, points out the weaknesses of electrical installation equipment from the maintenance point of view with particular reference to domestic and commercial installations; in addition, a few comments are given on industrial equipment, the design of which seems far more satisfactory. Wherever possible, improvements and remedies which are commercially practicable are suggested. The equipment has been considered under the headings of switch and control gear, cables and cable accessories, wiring systems and accessories, utilization, including domestic, commercial and agricultural applications, and industrial plant. In general, complaints fall into the four main categories of insufficient space for wiring, inadequate terminal arrangements, lack of standardization and lack of appreciation of the innate clumsiness of the general public. If manufacturers' future designs overcome these four fundamental difficulties, much perplexity will be saved in the maintenance and installation industry.

Agricultural Scholarships

THE Ministry of Agriculture and Fisheries invites applications for ten senior scholarships, tenable at agricultural colleges or university departments of agriculture, for diploma or degree courses in an agricultural subject or at veterinary colleges for courses in veterinary science; and for six extended junior scholarships (for those who have already held junior awards), and thirty junior scholarships, tenable at farm institutes or similar institutions, for courses not exceeding a year in duration, in agriculture, horticulture, dairying or poultry husbandry. The scholarships are open to the sons and daughters of agricultural workmen or of working bailiffs, smallholders and other rural workers whose means and method of livelihood are comparable with those of agricultural workmen, and to persons who are themselves *bona fide* workers in agriculture. The value of the awards is such that neither the recipients nor their parents are normally required to make any contribution towards the cost of training provided. The usual method of selection is by interview, no written examination being held. Further information can be obtained from the Secretary of the Ministry, Block 4, Bickenhall Mansions, Baker Street, London, W.1, or from the offices of County Councils. The latest date for submitting applications is April 30.

Recent Earthquakes

DURING December 1943, twenty-eight earthquakes were registered by the seismographs at the geophysical observatory at Toledo in Spain. The greatest of these occurred on December 1, and registered at 10h. 47m. 14s. from an epicentre some 87·2° distant from Toledo. The depth of focus has been estimated to have been 150 km. and the earthquakes gave rise to amplitudes of 130 μ at Toledo. The nearest earthquake to Toledo during the month occurred on December 31, registering at 19h. 29m. 24s. from an epicentre 240 km. distant. The next nearest occurred on December 26 from an epicentre approximately 470 km. distant. This last epicentre may have been in the Pirineos Centrales.

During December 1943, thirteen strong earthquakes were registered on the seismographs in New Zealand. The following had their epicentres tentatively determined at the Dominion Observatory, Wellington: (1) December 1, New Guinea region; (2) December 2, south of Kermedecs; (3) December 23, New Guinea–Solomons region; (4) December 24, New Guinea–Solomons region (two shocks); (6) December 27, near latitude 36° S., longitude 175° W.; (7) December 30, Kermedecs region. Additionally, twelve earthquakes were reported as felt during the month in New Zealand. The greatest of these was scale V (modified Mercalli) and happened in the neighbourhood of Whangamomona on December 3. This shock was also felt near Taumaranui.

Training for the Chemical Industries

IN an address to the London Section of the British Association of Chemists on March 4, Dr. T. J. Drakeley, principal of the Northern Polytechnic, made a strong plea for a recognized system of technical education in Britain on an equal footing with more academic subjects. He attributed the industrial decline of Great Britain—instanced by the dyestuffs and coke industries—to the lack of such a system of technical training, in contrast to the highly developed system of technical high schools on the Continent, such as those at Delft, Zurich, Stockholm and Charlottenburg. He criticized the report of the Chemistry Education Advisory Board for stipulating that the study of a branch of applied chemistry should always be preceded by a three-year degree course in pure science. He maintained it is impossible to justify the view that the metal chemist and the rubber chemist should have the same basic training. It is only on the basis of a trained personnel that the chemical industries can regain world markets, revive British prestige and pass into a prosperous period of progress.

Royal Society of Edinburgh Awards

THE following awards have been made by the Council of the Royal Society of Edinburgh: Keith Prize for the period 1941–43, to Prof. James Ritchie, professor of natural history, University of Edinburgh, for his papers in the *Proceedings* of the Society within the period of the award and in recognition of his distinguished contributions to natural history; Neill Prize for the period 1941–43, to Dr. Douglas A. Allan, director of Liverpool Public Museums, for his papers on "The Geology of the Highland Border Region", published in the *Transactions* of the Society.

Announcements

THE Council of the Iron and Steel Institute has awarded the Bessemer Gold Medal for 1944 to Mr. Essington Lewis, director-general of munitions and director-general of aircraft production for Australia, formerly of the Broken Hill Proprietary Co., Ltd., in recognition of his outstanding services to the iron and steel industry of Australia.

MR. JOHN G. WINANT, American Ambassador in Great Britain, on March 31 presented the Charles P. Daly Medal and the Cullum Medal of the American Geographical Society to Sir Halford Mackinder, formerly professor of geography in the University of London, and Mr. Arthur R. Hinks, secretary of the Royal Geographical Society, respectively.

PROF. J. M. MACKINTOSH, since 1941 professor of preventive medicine in the University of Glasgow, has been appointed as from October 1 to the University chair of public health tenable at the London School of Hygiene and Tropical Medicine. He was formerly chief medical officer to the Department of Health for Scotland.

SIR AUREL STEIN, who died on October 26, bequeathed his collection of Oriental manuscripts, notebooks of travels, and written papers of a scientific character to the library of the Indian Institute at the University of Oxford, and residue, subject to life interests, to form the Stein-Arnold Fund for exploration of the ancient civilizations of India, China and Iran.

THE following degrees have been conferred by the University of Aberdeen: *D.Sc.*: G. H. Rawcliffe, for a thesis on "Some Current, Voltage and Power Relations for Complex Mercury Arc Rectifiers"; *M.D.*: S. A. B. Black, for a thesis on "The Environmental Health of British Merchant Seamen".

ERRATUM. In NATURE of March 18, p. 351, the price of the report on Polyzoa issued by the Discovery Committee should read 35*s*. net, not 9*d*. net as printed.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Synaptic Transmission in the Spinal Cord

THE preparation used in this investigation has been either the spinal cord of the decerebrated or anæsthetized cat or the isolated oxygenated spinal cord of the frog, and it has been activated by electrical stimulation of a dorsal root (the 7th lumbar or 1st sacral in the cat, the 9th or 10th in the frog).

As Barron and Matthews[1] have shown, a single dorsal root volley normally sets up a large and prolonged negative potential of adjacent ipselateral motoneurones on which are superimposed spike potentials of discharged impulses (cf. ref. 2). The prolonged negative potential differs from the spike potentials in being decrementally transmitted by electrotonus along the axons of the motoneurones, and in the present experiments it has been recorded from the ventral root as it emerges from the spinal cord. This potential has been found to be diminished and shortened by nembutal anæsthesia, and ultimately with deep anæsthesia (about 100 mgm. per kgm. intravenously in the cat or prolonged soaking in 1 in 5,000 in the isolated frog's cord). A dorsal root volley sets up no spikes, but only a simple brief negative potential with a quick rise and a slower, approximately exponential, decay. It spreads electrotonically along the ventral root. The durations of latent period, time to summit, and time of half-decay are about 0·8, 3 and 7 msec. in the cat and 1·5, 5 and 25 msec. in the frog. When the potential is sufficiently large, owing either to a lower depth of anæsthesia or to summation of two or more successive responses, the motoneurones discharge impulses. The potential is thus analogous to the local catelectrotonic potentials set up by trans-synaptic stimulation of curarized ganglia[3] or neuro-muscular junctions[4,5], and may be termed a synaptic potential. Similarly, too, it appears to be set up by a brief active depolarizing agent, its decay being passive and governed by the electric time constant of the membrane.

The brief synaptic potential recorded in deep anæsthesia must be set up in the motoneurones by impulses in those dorsal root fibres which end in direct synaptic contact. By making the anæsthesia deep enough to block all synaptic transmission of impulses, the setting up of internuncial impulses has been prevented, and the spinal cord has been reduced to a single synaptic preparation (the two-neurone reflex arc). The complex and prolonged synaptic potential normally set up in motoneurones by a dorsal root volley results from summation of the synaptic potentials set up by bombardment of the motoneurones by the initial direct volley and later internuncial discharges.

With rapid repetitive stimulation (up to 200 per sec. in frog, 400 per sec. in cat) synaptic potentials in the anæsthetized cord sum to a plateau which decays abruptly on cessation of stimulation. There appears to be no building up of a persistent actively depolarizing agent such as gives the initial slowed decay with synaptic potentials of ganglia[3].

Eserine (intravenous doses up to 1 mgm. per kgm. in cats, prolonged soaking in 1 in 100,000 to 1 in 10,000 in isolated frog's cord) has no appreciable action on the time course of the synaptic potential of the anæsthetized motoneurones (single, double or repetitive stimulation). There is no trace of the prolonged junctional potential which was observed after repetitive trans-synaptic stimulation of the eserinized and curarized muscle or ganglion, and attributed to the accumulation and persistence of acetylcholine[6,7] Dale and co-workers have provided convincing evidence that acetylcholine acts as a synaptic transmitter at such junctions. With synapses in the central nervous system, however, there is no unequivocal evidence of synaptic transmission by acetylcholine, so the present negative results with eserine make it unlikely that acetylcholine plays any part in the synaptic transmission of simple spinal reflexes. On the other hand, the time course of the active depolarizing agent is so brief that it could be due to direct electrical stimulation of the motoneurones by the action currents of impulses in the terminals of the dorsal root fibres. Similarly, it was suggested[7] that the analogous brief transmitter action observed in sympathetic ganglia was possibly due to a direct electrical action, but with ganglia it is superimposed on the more prolonged depolarization due to acetylcholine transmission.

Synaptic transmission in the spinal cord is also different from that in muscle and ganglia in that it is not paralysed by curarine. In fact, curarine has the reverse effect, having a mild strychnine-like action in concentrations so low as 12 μmol. per litre.

JOHN C. ECCLES.

Physiology Department,
Medical School, King Street,
Dunedin, N.Z. Feb. 1.

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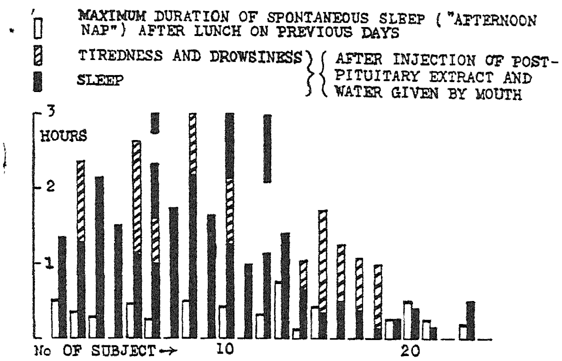
Induction of Sleep by Simultaneous Administration of Posterior Pituitary Extracts and Water

THE following investigation arose from considerations based upon well-known observations on the state of normal sleep. These are: (*a*) that during sleep the urine volume output is decreased and the blood diluted; (*b*) that many drugs (caffeine, etc.) which cause wakefulness are diuretics; and (*c*) that severe muscular work which, it is recognized, often facilitates the onset of sleep, has an antidiuretic action. It was thought, therefore, that the antidiuretic principle of the posterior pituitary, if given together with water, might possibly bring about an internal milieu so similar in many ways to that of normal sleep (for example, antidiuresis, dilution of the blood) that this state might eventually cause, deepen or prolong natural sleep.

Experiments were made on a number of subjects, many of whom were unaware of the object of the procedure, and were carried out after the average time had been recorded for which each subject would sleep spontaneously after lunch when good and repeatable conditions were given. Through the kind permission of Prof. P. C. Cloake and other clinicians, a number of these experiments were made on suitable hospital patients. Other experiments were made on students where, though the element of suggestion



could not be excluded entirely, some sham injections with saline gave negative results and thus offered a certain measure of control.

Nearly all experiments using 5–10 units of the pressor principle gave negative results, though the antidiuretic effect was, of course, marked. Some effects of these preparations (for example, peripheral vasoconstriction, eventual rise in blood pressure) were thought to be incompatible with normal sleep, where the blood pressure is relatively low. Oxytocic preparations were therefore tried and eventually it was found that 10–15 units of oxytocic preparations, still showing definite antidiuretic action, given together with 1–2·5 units of the pressor principle and 1½–2 pints of water (given orally), had obvious effects. These doses were split into two injections, usually given at 11 a.m. and 12 (noon), and were followed by the subject having a normal lunch. From 2 p.m. the subjects were kept in bed. From the accompanying figure it can be seen that of twenty-four cases treated in this way thirteen slept for long periods, five cases experienced drowsiness and tiredness, but without sleeping much longer than usual, and six cases gave quite negative results. An additional eleven subjects were treated in slightly different ways (1 per cent saline given instead of water, etc.). Of the total of thirty-five subjects (including those shown in the figure) eighteen slept longer than could be expected normally, eight exhibited symptoms of pronounced drowsiness, while nine felt no effects whatsoever. Symptoms like "the eyes feeling heavy and itching", prolonged yawning, etc., were often recorded. The symptoms never appeared until 2–3 hours after the last injection. The sleep was often very deep and dreamless, which was noted by those who usually dream. It seemed that women responded better than men ; thus of the nine negative cases seven were men. Some subjects mentioned spontaneously a pronounced well-being after the induced sleep. If the injections or the water were given alone, uncertain or negative results were obtained in eight cases.

Whether the described effect is due to the antidiuretic principle, or to the oxytocic one, or to both, cannot yet be stated. It may be that by creating much of the internal milieu of natural sleep, once that milieu is established, sleep may follow as a conditioned reflex, and that the actual chain of events at the normal onset of sleep may be different. The important fact, however, that most of the changes in composition and volume of the blood known to occur during sleep in man develop after merely lying down for 20–30 minutes[1,2] may suggest that the 'water shift' is among the earliest events concerned with the onset and maintenance of sleep, and that therefore the above described effect may not differ essentially from what happens at the onset of normal sleep.

F. Schütz.

Medical School,
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Feb. 23.

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X-Ray Divergent-Beam Photography as a Test of Crystal Perfection

In a recent communication[1] I reported that good type I diamonds gave bad divergent-beam photographs, the deficiency (absorption) lines being scarcely, if at all, visible against a foggy background, whereas type II diamonds gave excellent divergent-beam photographs. I suggested that this could be explained if the type I diamonds were 'ideal' and type II diamonds 'mosaic' in structure. The poor photographs would be an indication of large primary extinction.

Confirmation of this interpretation has come in other ways. Prof. E. N. da C. Andrade tells me that when he and Sir E. (afterwards Lord) Rutherford took the first divergent-beam photographs some thirty years ago, using the γ-rays of radium, they found that a particular ordinary cleavage plate of rock-salt gave moderately good absorption lines[2]. Specimens apparently much more perfect, as judged by specular reflexions of ordinary light, which were selected from a large number specially fetched from a salt mine, gave much inferior effects.

I said also in my communication that crystals of organic compounds gave good photographs. This was true of the substances I had then examined. Further experiment has, however, revealed some notable exceptions. Three out of five crystals of oxalic acid dihydrate gave either no visible lines or lines so faint as to be seen only with the greatest difficulty ; the fourth gave a picture of moderate contrast and the fifth an excellent one. Very poor photographs were given also by erythritol, ammonium oxalate, stilbene, hexamethylene tetramine and a thin cleavage plate of calcite. Sucrose, mannitol, tolane, *trans*-azobenzene, 1-3-5 triphenylbenzene, penta-erythritol and penta-erythrital tetraphenylether gave lines of only moderate visibility. Anthracene, benzil, dibenzyl, benzophenone, maleic acid, maleic anhydride, succinic acid, α-resorcinol, urea nitrate, hexamethylbenzene and hexaethylbenzene gave good clear pictures, although even among these some were distinctly better than others. Only one or two crystals of each of these substances were examined, and the results, therefore, must not necessarily be accepted as typical of the compounds in question. They are given to show what wide variations may exist.

In order to find out whether the absence, or comparative indistinctness, of absorption lines did, in fact, indicate the approach of the crystal to an 'ideal' state, with its resulting primary extinction effect, I dipped two of the oxalic acid dihydrate crystals into liquid air for a few seconds and rephotographed them when they had regained room temperature. The result was that a pattern appeared where none had been seen previously. A second immersion improved the sharpness and visibility of the absorption

lines, although they did not become quite so good as those of the naturally 'mosaic' specimen. The crystals became very brittle; presumably the small-scale breaking-up of the structure into slightly disorientated crystallites (which for complete absence of primary extinction would have to be about 1 μ or less in linear dimensions) was accompanied by cracks on a very much larger scale. Erythritol, stilbene and hexamethylene tetramine also gave good pictures after immersion in, or spraying with, liquid air, and some of the moderately good specimens (sucrose, mannitol and *trans*-azobenzene were tested) gave much improved pictures after similar treatment. Type I diamond and calcite, however, were apparently not affected even by repeated coolings. Those crystals the structure of which had been broken down into a mosaic by sudden cooling continued to give a good divergent-beam photograph even after an interval of more than 100 hours; there was no evidence of any recrystallization.

It is clear that, when X-ray structure analysis is being carried out, the possibility of large primary extinction effects existing even in small crystals of so-called 'soft' organic compounds must not be ruled out of consideration. That some primary extinction takes place in crystals of less than 0·1 mgm. weight was indicated by B. W. Robinson's comparison of the structure factors of anthracene deduced from single crystals[3] and from a fine powder[4], using copper and molybdenum monochromatized radiations in each case. Other workers[5,6] have reported marked primary extinction in single crystals of hexamethylene tetramine, which was reduced by liquid air treatment or eliminated by the use of a fine powder. In spite of these warnings, however, primary extinction has on the whole been neglected in recent years, partly because of the obvious difficulties of allowing for it. My experiments seem to show that some technique of detection and elimination will be essential in all X-ray analytical work where accuracy is desired. If such a technique is not adopted, there is no point in using very accurate methods of intensity measurement.

Large-scale distortion of crystals is readily detected by the divergent-beam method. Several diamonds gave photographs in which there was a general blurring of the lines in one particular direction, or in which lines were doubled which should have been single. It is a simple matter to calculate, from the photographs, the amount and direction of disorientation of individual crystallites necessary to give these effects.

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Royal Institution,
London, W.1. March 8.

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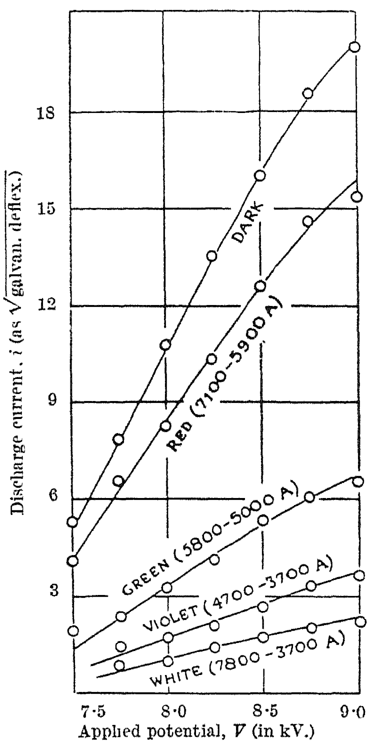
Light-Effect in Chlorine under Electrical Discharge: Influence of the Gas Pressure

AMONG numerous factors which determine the magnitude of the diminution Δi on irradiation of the discharge current i[1–6], the gas pressure p has been found to have a marked influence. The rectifier type A.C. indicator used previously[3] was replaced by a Cambridge vacuo-junction; this increased appreciably the sensitivity of the arrangement, since the corresponding galvanometer deflexions are proportional to i^2.

The characteristic curves in the accompanying graph refer to a discharge produced in a Siemens' ozonizer B, the applied potential V varying over the range 7–12 kilovolts (r.m.s.) at 50 cycles frequency, (i) in the dark, (ii) under irradiation from four 200-watt bulbs run at 180 volts, with a water-filter to minimize the heat effect; and with (iii) violet, (iv) green, and (v) red filters added to (ii). Using the water-filter, the relative intensities observed with a thermopile were: white (100), red (40·6), violet (16·7) and green (1·5); the transmission limits (see graph) were found from spectra taken with a Fuess' glass instrument. At $p = 0·8$ cm. mercury, Δi was not detected despite large variations of V. At $p = 59·6$ cm., Δi for (ii) white, rose from 13 to 35 per cent of i in the dark as V was increased from 9·3 to 11·2 kV.; at high applied potentials the discharge was unsteady; and also Δi was smaller and irregular. The light-effect was a maximum at 46·5 cm.



The intensity in the violet region (4700–3700 A.), especially towards its short-wave end in (ii) unfiltered white, was much greater than in (iii) the filtered violet. As Δi increases in the order, red < green < violet < white, which is different from their relative intensities, the frequency is the major determinant of this phenomenon. That, compared with the green and red, (ii) white and (iii) its violet component contain a much greater part of 2300–5000 A., the chief absorption band of chlorine[7], is possibly an additional factor[3,5,6]. The accompanying curve shows that Δi increases with V and that this influence increases in the order red < green < violet < white. This agrees with our results at various pressures. Further work has shown that $\Delta i/i$ is a more regular function of i than the corresponding V. The precise nature of any of these $\Delta i/i - i$ curves, however, depends

markedly on the pressure. This relation is simple at 46·5 cm.; approximately, $\Delta i/i$ is a constant, dependent upon the light-band.

At this pressure, it was interesting to observe, for example, at 9·0 kV. that, in the dark, i gave a deflexion of 400 units; under (ii) white, it was reduced to 2; corresponding to a light-effect of about 93 per cent. This, together with the fact that it has been observed in some compound and elementary gases, with the exception so far of the rare gases and metallic vapours, indicate a hitherto unrecognized and fairly widespread factor in the electrical discharge and photo-electric phenomena.

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Feb. 19.

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An Interferometric Procedure for the Examination of Crystal Surfaces

IN a recent communication[1], Dr. S. Tolansky has described an interferometric method for the study of crystal surfaces. He includes two pictures showing the surface structures of mica and selenite.

This method has been used to great advantage in our laboratories for several years, especially for selecting suitable crystals for X-ray crystallography. In a paper[2] published in the proceedings of the Swedish Academy of Sciences for 1933, some fifty pictures from different crystals, calcite, topaz, quartz, gypsum, mica, rock-salt, sylvine and carborundum were reproduced. All these crystals, even the most perfect ones, gave contour patterns of the cleavage faces showing that the surfaces were split up into a great number of regions with different heights. In calcite, for example, the steps were of the order $0 \cdot 1\ \mu$ and less. It was mentioned in the paper that the method made it possible to measure the steps with an accuracy of 5 A.

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Academy of Sciences,
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Jan. 3.

[1] Tolansky, S., NATURE, **152**, 722 (1943)
[2] Siegbahn, Manne, *Ark. f. Mat., Astr. o. Fysik.*, **23**, A, No 12 (1933).

PROF. SIEGBAHN has very kindly sent me a reprint of his paper referred to in his letter; the journal in which it appeared is not available here and I was completely unaware of the existence of the paper.

I cannot agree, however, with Prof. Siegbahn's implication that his method and mine are the same. They are, in fact, very different optical procedures, since Prof. Siegbahn employs the classical *two* interfering beams, whereas I make use of the far more powerful *multiple-beam* interference. As a result of this the resolution in the two cases is of a different order. One can consider as an analogy that his resolution is to mine as the resolving power of a 2-line grating is to that of a 40-line grating. The intensity distributions within the two types of fringes are so fundamentally different that the multiple-beam procedure gives an accuracy of an entirely higher order.

While both methods reveal the coarser details of crystal surfaces equally well (and Prof. Siegbahn's paper contains many beautiful reproductions of fringes revealing coarser details), yet the more precise multiple-beam procedure reveals in addition subtle fine structure details far beyond the possibility of the simpler two-beam method. This difference is entirely a question of fringe width, and the employment of very high reflecting coefficients in my method is responsible for the improvement.

Prof. Siegbahn states in his paper that when his fringes are measured with a photometer, their *positions* can be determined to within 1/500 of an order (despite the very unfavourable $\sin^2$-intensity distribution). This is only 5 A. It is, of course, quite evident that the smallest *step* which he can resolve is much greater than this figure, which is the error in setting on a fringe. With my method, I can readily measure directly (without a microphotometer) actual steps so small as 30 A. in height with an accuracy of 1 A. It is more than probable that with a microphotometer this would be reduced by a factor of 2. Such *resolution* simply cannot be approached with fringes produced by two interfering beams, hence the two procedures cannot be considered equivalent.

While, therefore, the two-beam method is quite sufficiently sensitive for the purpose of selecting suitable crystals for X-ray crystallography, as a method of high precision for revealing the fine structure topographical details of crystal surfaces, it cannot compare with the multiple-beam procedure that I have independently developed. This is perhaps most clearly revealed in a more recent publication of mine[1].

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[1] NATURE, **153**, 195 (1944).

Metabolism of Acetoacetic Acid

IN a recent publication Breusch[1] has reported experiments suggesting a condensation of the $-CH_2.COOH$ group of β-ketonic acids with oxaloacetic acid, resulting in the formation of citric acid.

Shortly after the theory of the citric acid cycle was first put forward by Krebs and Johnson[2], and following the observation of Korányi and Szent-Györgyi of the antiketogenic effect of succinic acid[3], I performed a number of experiments designed to test this very hypothesis. Acetoacetic acid was incubated with slices of rat brain and kidney with and without the addition of various members of the citric acid cycle. The observed effects on oxygen uptake, formation of citric acid and disappearance of total acetone bodies were, however, so small as to be inconclusive. The theory was abandoned on the strength of the following experiment in which the anaerobic disappearance of total acetone bodies was measured by a modified Messinger titration[4,5].

TISSUE INCUBATED FOR 2 HR. IN BICARBONATE-RINGER (N_2/5% CO_2).

Tissue	mgm dry weight	Substrate	Q Aceto-acet.	$Q\beta$-Hydr-oxybutyr.
Rat brain	15 29	acetoacet. (0·002 M.)	—0·49	0·23
	19 92	,, + oxaloacet (0 0067 M.)	—0 55	0 37
Rat testis	33·62	acetoacet. (0·002 M.)	—0·98	0·38
	44 39	,, + oxaloacet. (0·0067 M.)	—0 69	0 35
Rat kidney	14·39	acetoacet. (0·002 M.)	—1·57	0 81
	9·76	,, + oxaloacet. (0·0067 M.)	—1·64	0·85

The reaction acetoacetic acid + oxaloacetic acid → citric acid + H_2O does not require oxygen. According to Breusch[1], the enzyme is insensitive to cyanide. One would have expected, therefore, that addition of oxaloacetic acid would raise the anaerobic rate of acetoacetic acid disappearance to the level of the aerobic rate (Q-value of about 6 for kidney and about 2 for brain). The addition of oxaloacetic acid was, however, without effect.

Moreover, it was found in these experiments that the ratio of acetoacetic acid disappearing to β-hydroxybutyric acid formed was roughly 2 : 1, a result typical for a dismutation, and it was concluded that the first step of acetoacetic acid metabolism is oxidative, or at least reversibly linked with an oxidative step. This, too, was not in agreement with a mechanism where the first step would have been a non-oxidative condensation. Subsequent investigations[5,6] gave no evidence for oxidation at the α- or the γ-position or for an oxidative cleavage into two C_2-compounds.

Though the limited value of negative evidence is fully realized, it remains to be explained why the expected results were not observed under the conditions employed.

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Effect of Temperature on the Reducing Activity of Leucocytes in Milk

SOME investigations were carried out as to the possibility of milk from cows infected with mastitis having an increased reducing activity due to the number of leucocytes contained in it, and in consequence failing the Standard Routine Resazurin Test adopted by the Ministry of Agriculture for the grading of milk under the National Milk Testing and Advisory Scheme. During the course of this work, milk samples with a high leucocyte content were submitted to ten-minute and one-hour resazurin tests at 37° C. immediately after production, and then again after holding the milk overnight at different temperatures, so as to attempt to reproduce the varying atmospheric temperatures at which milk is held before testing.

As will be seen from the accompanying results, milk held at 55° F. overnight did not reduce resazurin so rapidly as when tested immediately after production. This is no doubt due to the fact that leucocytic metabolism in milk is entirely catabolic and not anabolic ;

VARIATION IN THE RATE OF REDUCTION OF RESAZURIN DUE TO HOLDING THE MILK AT DIFFERENT TEMPERATURES.

	Resazurin disk reading at the end of		Complete reduction of resazurin
	10 min	1 hour	
Tested immediately after production	4	0	1 hr
Tested after holding at 55° F. overnight	4½	1½	1½ hr.
Tested after holding at 40° F. overnight	0	0	10 min.
Tested after holding at 32° F. overnight	2½	1	1½ hr

for this reason the life of the leucocytes in milk is probably dependent upon the temperature at which the milk is held, and the nearer the temperature is to body temperature the shorter the life of the leucocytes, and the lower the temperature (providing that it is now low enough actually to damage the cells physically) the longer the life of the leucocytes.

If this is so, milk with a high leucocyte content should not reduce resazurin so rapidly after it has been held at temperatures approaching body temperature, and milk held at lower temperatures should reduce at approximately the same rate before and after holding. This has been found to be so, except in the case of milk held overnight at 40° F., when the reducing activity of the cells appear to be definitely increased for no apparent reason.

In all cases a bacterial plate count test was carried out to ensure that any increase in reducing activity was not due to the growth of cryophilic bacteria in the milk during the holding period.

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The Soil as a Source of Infection of Dry Rot of Potato

IT has long been suspected that the fungus causing dry rot (*Fusarium caeruleum*) is present in field soils[1,2] and in soil adhering to seed tubers[3], but, so far as I am aware, no direct proof, based on experimental evidence, has been published.

In 1942, inoculation of susceptible tubers with unsterilized field soil, previously sprayed with a spore suspension of *F. caeruleum*, caused dry rot to develop. The result suggested that this direct inoculation method with soil might be useful to prove the presence of the fungus in field soils and in soil adhering to seed potatoes.

In 1942 and 1943, soil samples were obtained from several farms in Cheshire ; each sample consisted of soil scraped from thirty tubers with a sterile knife and collected in a new envelope in the field at digging time, before the tubers came into contact with any possible source of infection such as hampers, seed boxes or sacks. All the samples proved to be infected. Suitable controls remained sound. Similar results were obtained with many samples collected at random from healthy seed tubers stored in seed boxes in lofts during the winter 1942–43.

During the present winter soil samples were collected at wholesale merchants' stores from seed potatoes imported from Scotland and from Northern Ireland. From each consignment ten of the top-

most tubers were taken from each of three sacks; sacks seen to contain diseased tubers (there were very few of these) were not sampled. Of forty-two samples tested (thirty-three from Northern Ireland and nine from Scotland) thirty-seven were infected.

In the above work, re-isolations and re-inoculations were made frequently; the Fusarium sp. isolated have not yet been identified, but all of them produced dry rot when inoculated into test tubers. The *p*H value of the infected soil samples ranged from 5·16 to 6·74.

The results establish that the fungus (or fungi) causing dry rot of the potato is frequently present in field soils in Cheshire and in soil adhering to imported seed tubers before these are distributed to farmers. To prove that field soils in Scotland and Northern Ireland are infected (as is suggested by these results), it would be necessary to collect the samples in the field at digging time.

The method is being used to test loft sweepings and soil adhering to tubers before and after seed treatment with organo-mercury preparations.

The implications of these findings will be discussed in a later publication.

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Agricultural Advisory Department,
University of Manchester. Feb. 23.

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Training for Citizenship

As one who has learned to look to science for a more dependable kind of guidance, I suffered a feeling of disappointment while reading the article entitled "Training for Citizenship"[1].

The deprecation of the omission of any reference to the value of science as a social discipline is mentioned; but the absence of a scientific approach to the problems of education is ignored.

The creed of 'world-citizenship' is applauded. "If we are all good citizens all the other good things will follow." Such an utterance sounds suspiciously like the very dogma of religious belief that science has struggled for centuries to supersede. Surely there is sufficient evidence of relationship between biological knowledge and educational problems for a scientific approach to be made.

Prof. Julian Huxley describes evolutionary progress as "increased control over and independence of the environment. As an alternative we might define it as a raising of the upper level of all-round functional efficiency and of harmony of internal adjustment"[2].

It does not appear illogical or impracticable to interpret this progress into terms of everyday productive and cultural behaviour of individuals. Neither does it appear unscientific to assert that there can be no fundamental difference between the impetus directing the behaviour of an individual and that of the species to which the individual belongs. If this be sound, then the purpose of education may be accepted to be the imparting of knowledge to aid individuals to solve the problems they may meet in their everyday life in a manner which conforms, so far as is practically possible, to the needs of society as an organic whole. The scientific approach is to gather data from the field of everyday behaviour and, in the light of biological and sociological knowledge, define the problems arising from conflict between inner impulses and environmental conditions. After an adequate definition is formed, the hypotheses of education and citizenship may be framed.

The too-academic man of science appears to overlook the fact that most human problems are social and economic in character. Science has already provided methods of dealing with mathematical problems. It is possible for an individual with an elementary school education to solve everyday problems of numbers with his knowledge of arithmetic. It is possible for him to develop his ability to deal with more complex problems of the same sort from the knowledge made available to him by science in a completely progressive manner. A similar facility exists, through the technical levels, in all branches of the physical sciences.

No such progressive ladders are provided by science in the fields of sociology and economics. If they are, the rungs begin too high. We must bear this condition in mind when scientific efforts are devoted to creating conditions of efficient education and 'world-citizenship'.

It must be remembered that types of education already exist and some have existed for many generations for nine-tenths of our population in the forms of newspapers, cinemas, magazines, music-halls, radio, advertising, foremen, salesmen, policemen, etc. (Some of them are applied far more scientifically than the types recommended in NATURE, and are, therefore, more successful in their results.)

Although these types of education lead to commercial and other solutions in accordance with the interests of small groups instead of cultural solutions in accordance with the interests of democratic society, the fact remains they are the sources of instruction received and the directing-forces of everyday behaviour.

Sufficient evidence can be found among sociological data to indicate that individuals do not integrate with groups, or small groups with wider groups, unless an anticipation exists that the consequences will lead to an all-round independence of environment.

The problem confronting the social scientific worker is to explain how individual independence of environment can only increase with an increasing interdependence on the social environment. The next problem—a technical one—is to make it happen.

Unfortunately, for a large number of people the benefits of socialization are not converted into individual advantage. Sometimes it results in a loss. To expect co-operation from individuals whose experience proves it to be detrimental to their conditions of living and to expect them to become conscious of the need for world-citizenship without evidence different from that derived through their common sense is as unscientific an assumption that can possibly be made. It is contradictory to all scientific knowledge.

While the conflict between inner urge and material environment continues, and while a scientifically directed form of government (which must include education up to the world-citizenship level) fails to materialize due to a false approach, then the practical consequences are likely to be of an explosive character that will force a more natural direction.

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[1] NATURE, **153**, 265 (1944).

[2] "Evolution", p. 564.

THE OAK TREE

By ALEXANDER L. HOWARD

"*Stabat in his ingens annoso robore quercus; una nemus.*" (In aged majesty a mighty oak towers o'er the subject trees, itself a grove.)—OVID.

FROM earliest times the oak tree has been held sacred by all people in all countries, and it is not surprising that it was worshipped by the rude and savage barbarians who inhabited Great Britain two thousand years ago, when Druids held their services under their sacred oaks. In comparison to their ignorant and primitive forms of worship it is good to think that these wild people were impressed by the solemn beauty of their great forests, where tall trunks of trees, roofed in with foliage, made natural cathedrals in the open air.

Apart from its beauty and grandeur the oak tree has played a vital part in the growth of our great Empire; in the reign of Queen Elizabeth our small battleships were built almost entirely of oak.

Boulger quotes it as having been the favourite timber of Greeks, Romans, and Norsemen—the latter having used it for the bulding of their long ships. He also tells us how the great iron industry of Sussex, which supplied the cannon for Elizabeth's Navy, relied for smelting upon an inexhaustible supply of British oak.

During the War of 1914–18, at a time of crisis, when foreign supplies of timber failed, the nation once again depended upon the faithful services of this mighty tree.

In a tree song which he dates A.D. 1200, Kipling says:

> England shall bide till judgment tide,
> By oak, and ash, and thorn.

Yet now that we have become in many respects a cultured and enlightened nation, there are ominous signs that the immense value and importance of the oak tree has been forgotten.

Those of us who have seen the great oaks that have been felled during the last twenty years cannot fail to have observed that there were definitely three outstanding plantings: the first, and most important, probably being self-sown, and dating back approximately twelve to fifteen hundred years; the second can be placed about 1450; and the third about 200–250 years ago. On the grassy bank beneath the church at Northiam, Sussex, can be seen two interesting examples—a venerable giant of the earlier date, and slightly lower down the bank a lesser giant, which probably belongs to the second era. Still lower there is a healthy youngster of about forty years, which, however, has been identified as a fine specimen of *Q. Merbeckii*, a semi-evergreen oak, native of northern Africa, which retains its leaves until the New Year. The Knightwood oak, near Lyndhurst, in the New Forest, still stands; until a year or two ago "The Twelve Apostles", in Lord Petre's Park, at Brentwood, Essex, and many other veterans were still flourishing. On Sir George Courthope's estate at Whiligh, near Tunbridge Wells, is an oak tree which can be best described in his own words:

> "the old manorial map which showed a little picture of 'ye olde oake' in more or less its present condition, was dated 1493. The bark is most vigorous. When I was a child there was an opening over two feet wide into the hollow trunk, in which several persons could sit. The opening is now only a few inches wide."

Near by is another fine example, the age of which is unknown, but which I thought might belong to the second category of about 450 years ago. Sir George Courthope describes it as follows:

> "The specimen oak today has a girth of exactly 15 feet five feet from the ground, and is practically cylindrical until the spring of the first two branches, just over thirty feet up. The stem continues from another 10 or 12 feet to the main spring of boughs. It still grows. In, I think, 1920, when the Royal Arboricultural Society first came here, Henry Elwes and Dr. Henry saw the tree for the first time. The girth was then just under 14 feet, and the volume of the log was calculated at 410 cubic feet. In 1914 a would-be buyer . . . offered me £317 f.o.v. . . . for the log up to the second spring of boughs, which they calculated at 634 cubic feet. The haulage of so great a log would have destroyed three-quarters of a mile of farm road and half a mile of carriage drive; so the tree still stands."

It would appear from Sir George Courthope's records that two other somewhat similar trees were taken from the west side of the house and used for the restoration of the Westminster Hall roof. The Clerk of Works to the House of Commons counted more than five hundred annual rings in a squared beam (heartwood only) which was used for this purpose. About thirty years ago another specimen belonging to this category was felled at Danbury Palace, in Essex. This is referred to in "A Manual of the Timbers of the World":

> "it had five secondary trunks growing out of the butt, all of which were of a very rich brown colour. After the tree was sold a man was idly pulling out the decayed wood from a hollow in the side of the trunk, when he felt something hard, which he discovered was a small coin, afterwards found to be of Roman origin."

The authority H. J. Elwes was sceptical about these accounts of the great age of the oak tree—a doubt shared by Sir Geoffrey Evans—but as a result of years of careful study, despite the opinion of these two authorities, I still believe in them. Under the best conditions I think the oak continues to flourish for about five hundred years: apparently a further span of two hundred years follows, during which time little change is noticeable, and afterwards five hundred years or more will be passed before it reaches its last stage. A good example of this later condition can now be seen by the church at Hawkhurst, in Kent, where there is an old oak, its life finished, but the dead remains bricked in. One other, which is still producing a few shoots, can be seen by the church at Catsfield, in Sussex. The historic oak tree at Hatfield Park, now a hollow shell filled with concrete and fenced around (said to have been dead for about sixty-five years) can still be seen. According to tradition, it was under this tree that Queen Elizabeth was resting when she received the news of the death of her sister—Queen Mary. Every care has been taken to preserve it, and there is a tablet painted stating that it is the identical tree. There is every reason to accept this story, and if such be the case we may well believe that four hundred years ago the tree was flourishing, and it is likely that at that time it would have been more than 500–600 years old. In the near neighbourhood, at Brocket Park, a tree still stands, which produces a good crop of leaves year by year. This tree is taken care of and valued for its antiquity. The butt, measuring 32 feet in circumference, is clothed with sound healthy bark to a height of 12 feet, where it breaks out with immense limbs, which still produce an abundance of

rich green leaves. It has sometimes been claimed that it was under this tree that Queen Elizabeth received the news, but the history of Hatfield Park negatives the claim of Brocket Park.

Fifteen hundred years ago Pliny tells us :

"In the same North climate is the mightie forrest Hercynia. A huge and large wood this is, stored with tall and big okes, that never to this day were topt or lopt. It is supposed they have beene ever since the creation of the world, and in regard of their eternall immortalite surmounting all miracles besides whatsoever. And to let passe all other reports which happily would be thought incredible, this is knowne for certaine, that the roots of the trees there, run and spread so farre within the ground, that they encounter and meet one another: in which resistance they swell and rise upward, yea, and raise up mounts of earth with them to a good height in many places: or, where as the earth followeth not, a man shall see the bare roots embowed arch-wise, and mounting aloft as high as the very boughes: which roots are so interlaced, or else rub one against the other, striving (as it were) not to give place, that they make a shew of great portailes or gates standing open so wide, that a whole troupe or squadron of horsemen may ride upright under them in ordinance of battell."

For near 250 years the planting and conservation of the oak tree has almost ceased, and during this critical time prodigious demands have nearly destroyed the last reserves in Britain. Nor is this the worst. Before the War, the numerous country sawmills found it a profitable business to handle small and immature trees, because the plant at their disposal was unsuited for the larger sizes. Meeting a vigorous demand caused by the ever-increasing building operations which have continued since the War of 1914–18, and finding owners hard put to it for death duties and increased taxation, great numbers of oak trees of 60–150 years growth have been reluctantly sacrificed. Indeed, since the present War began, whole tracts of beautiful woodlands have been ruthlessly cut down, quite regardless of size and age, and a host of parks throughout the country have been denuded of timber-like trees.

At three successive periods of our history, the Government or the reigning monarch has recognized the urgency of the situation, so that in the reign of Edward I, again in Elizabeth's time, and lastly in Charles II and James II reigns, laws were passed prohibiting the felling of trees. We read of how Samuel Pepys was greatly troubled on account of a strange situation concerning the Duke of Albemarle and the Earl of Clarendon with regard to the oak trees in Clarendon Park. Pepys notes in his Diary on July 23, 1664, that he would "rather fling away the gains of £2,000 or £3,000, than have it said that the timber *which should have been the King's* . . . was concealed by us in favour of my Lord Chancellor". It would be well if the same spirit which animated the people of those days could be revived again to-day. The fierce flame which burnt in those stormy times is illustrated by the action of the Duchess of Monmouth, who took revenge on King James after her husband had been beheaded, by cutting in half all her oak trees at Moor Park, in order that the timber should not be employed in the building of the King's ships.

The debate in Parliament (1943) possibly marked the second occasion only in more than a hundred years, when this subject of such vital importance to the State received the attention of the Government. One fact alone which emerged should open many eyes, and that is that the soil and climate of Britain can and will produce a growth of forest wealth as good and better than any other country of similar character.

It would, of course, be ridiculous to plant the oak tree in uncongenial areas ; but it should be planted, and planted again continuously, in those soils and counties where it flourishes. Natural regeneration of oaks occurs year after year, and trees so produced have a sturdier and better growth than anything that can be planted. Such areas should be preserved by law, as they have been for years past in southern Europe and elsewhere. No person or municipality should be allowed to cut down any tree, either mature or immature, unless he can prove to the recognized authority that he has planted at least five to take its place, or alternatively, that he has wired against vermin and preserved a naturally regenerated area of equal value.

Elwes mentions in "Timbers of Great Britain and Ireland" innumerable species of oak (*Quercus* sp.) as established in Great Britain, but in this article I shall confine myself to four which I consider the most important, namely, *Q. pedunculata* Ehrh. ; *Q. sessiliflora*, Salisbury ; *Q. Cerris*, Linn. ; *Q. Lucombeana* (Sweet).

Q. pedunculata is represented by many thousands of trees in all parts of England, Wales and Ireland, and in a smaller degree in Scotland. These trees are of all ages, sizes, and in all conditions, but alarmingly reduced in number throughout the last 50–70 years. To-day *Q. sessiliflora* is rare, and a careful search and inquiry carried out during the last forty years convinces me that it has never been abundant in Great Britain. Mr. D. W. Young, the deputy surveyor of the New Forest, tells me that there are considerable tracts in certain parts, but I and many others who have sought for them have never been successful in our search, and I think this species has been introduced from the Continent, an opinion which is shared by others. In beauty as well as in timber, despite the controversy which has persisted since the time of wooden ships and the writings of Laslett, we can safely say that these first two species have equal merit.

In strength and durability there is nothing grown in our country which can compare with British oak, and indeed, although the oaks of America, Canada, Northern and Southern Europe, Japan, etc., are very numerous and approach equality, it may be safely affirmed that the British oak is pre-eminent. In the days when our stout ships travelled the seas, there was nothing else that could have been found strong and sturdy enough to provide the main structure and the planks, and we have an intensely interesting and informative account of the manner in which the utmost care was taken to bring into use the huge branches with their gnarled and twisted growths, so that the limbs of the crown of one single tree were of more value than the huge trunk which supported them.

The Rev. C. A. Johns tells us about a tree which was felled in the New Forest :

"It stood singly in the wood, and extended its massive branches nearly 40 feet each way. Its head was all knees and crooks, aptly suited to naval purposes ; its bole or shaft was short, not exceeding 20 feet in length ; but it was full 6 feet in diameter at the top, and perfectly sound. It was felled in an unusual manner for the preservation of its crooks, which were cut off one by one whilst the tree was standing, and lowered by tackles, to prevent their breaking. The two largest arms were sawed off at such distances from the bole as to make first rate knees ; scaffolds were then erected, and 2 pit saws being braced together, the body was first cut across, half through at the

bottom, and then sawed down the middle, perpendicularly between the two stumps of arms that had been left, at the end of one of which stood a perpendicular bough, bigger than most timber trees. To prevent this being injured a bed was made of some hundreds of faggots to catch it when it fell. This half was so weighty that it crushed a new timber carriage all to pieces the instant it was lodged upon it; and none in the country being found strong enough, the King's carriage was sent purposely from Portsmouth to convey it to the Dockyard. This tree was sold in the 1st place for £40, was bought of that purchaser by a timber merchant for £100, who is supposed to have cleared £100 more; which he might very well do, for the contents amounted to 32 loads of hewed timber, which at 2/6 a foot—no unusual price for naval crooks—amounts to £200 precisely, besides faggots etc. sufficient to defray expenses. The breadth of the tree across near the ground, where it was cut was 12 feet."

It is impossible to catalogue the great number of uses for which oak is preferable to any other British home-grown woods, nor is it necessary, as its qualities are so widely known. Perhaps, however, its uses for panelling or general interior decorative woodwork are not sufficiently recognized. When it was first used in this capacity the superiority of English-grown oak over that of foreign origin was apparent. By degrees its merits appear to have been forgotten, so that importations of foreign competitors became fashionable. Proprietors, proud of their rich inheritance of real old English oak panelling, recognized its value, but new aspirants failed to understand that imported oak was not comparable with British. There is no oak obtainable from any part of the world which will assume the rich golden colour or the attractive figure of English-grown oak, which should not be polished, but left from the tool. Quoting from "A Manual of the Timbers of the World", p. 364:

"When certain individual British oak trees (*Quercus Robur*) are felled, their ordinary heart-wood is found to be partially or wholly changed into a richer toned reddish-brown wood which is known as 'brown-oak'. It was formerly, and indeed it is occasionally even now, among English timber merchants and others in this country, called 'red oak'. The colour is much like that of polished crocodile leather, very variable in character, depth, and richness. It may be uniformly of a comparatively light brown, or again a deep rich brown, having in some cases lighter streaks; while in some portions from one to two inches wide, the ordinary colour does not appear to have been affected at all; again, the warm brown may be spotted and streaked with almost black veins, presenting a rich appearance. This last form is called 'tortoise-shell' pattern."

The beauty and usefulness of this brown oak has never been properly appreciated in England, but curiously enough the demand from America has been persistent and considerable. To meet this demand during the last half-century many thousands of the oldest and best trees which we possessed have been shipped across the Atlantic.

It is commonly known that the sapwood of oak should never be included with any woodwork requiring a long life. The sapwood decays very rapidly, and moreover it is particularly liable to attack by the Lyctus and Zestobium beetles, and fungi. The attack from beetle will often begin within a year after the work has been finished, and will certainly appear in the course of years. Having started, it will invariably spread to the heartwood, and it is therefore essential that sapwood should be entirely excluded. Hitherto it has been rare to find any oak woodwork which has been installed, completely free from the inclusion of sapwood, and the failure to insist upon this practice has been the cause of most, if not all, of the trouble which has been experienced.

With reference to durability, Elwes tells us:

"Many cases have been recorded and published of the great durability of the timber of the oak under ground and under water; but I have come across no relic of the past so interesting in this respect as the prehistoric boat which was dug up at Brigg, in Lincs. in 1884. This wonderfully preserved dug-out was hollowed out of one huge oak log $48\frac{1}{2}$ feet long and approx: 6 feet in diameter, which showed no signs of branches, a log which must have contained nearly 1000 ft. of timber, and which could not be matched now in England, or so far as we know, in Europe or N. America. The boat is 4 ft. 3 ins. wide by 2 ft. 8 ins. deep at the bows, and 4 ft. 6 ins. by 3 ft. 4 ins. at the stern, which was the root end of the tree. The sides are about 2 inches thick, the bottom 4 inches at the bows, and as much as 16 inches at the stern. One stern piece was ingeniously fitted in, though not found in situ, and a large rift on one side had been still more cleverly repaired with wooden patches caulked with moss. No metal had been used in any part of it. The boat was found imbedded in the blue & brown clay which underlies the peat, and is considered on geological evidence, which is given with great detail, to be from 2600 to 3000 years old."

The Lucombe oak (*Q. Lucombeana* (Sweet)) produced something of a sensation in arboricultural circles when in 1773 William Boutcher wrote as follows:

"About 7 years since, Mr. Lucombe of St. Thomas near Exeter, sowed a parcel of acorns, saved from a tree of his own growth, of the iron or wainscot species. When they came up he observed one amongst them that kept its leaves throughout the winter. Struck with the phenomenon, he cherished and paid particular attention to it; he propogated it, by grafting some thousands from it, which I had the pleasure of seeing, 8 days ago, in high flourishing beauty and verdure, notwithstanding the severity of the winter. Its growth is straight, and handsome as fir; its leaves evergreen: and the wood is thought by the best judges, in hardness and strength to exceed all other oaks. It makes but one shoot in the year, viz. in May, and continues growing without intermission: whereas other Oaks shoot twice, viz. in May and in August. But the peculiar and inestimable part of its character is, the amazing quickness of its growth, which I imagine may be attributed (in some degree at least) to its making but one shoot in the year: for, I believe, all trees that shoot twice are some time at rest before they make the second."

Although Boutcher reported the oak as evergreen, it is more correctly described by Elwes as "sub-evergreen", retaining its leaves until the following year.

It appears that Mr. Lucombe had in his nursery a specimen tree of the cork oak (*Q. suber*) near a specimen tree the Turkey oak, *Q. Cerris*, and that he concluded that the flowers were pollinated by the cork tree. This opinion was afterwards confirmed by Sir Hugh Beevor, who raised a similar tree under the same conditions. Messrs. Salter, Simpson & Sons, of Attleborough, have informed me under date of Feb. 1, 1944, that the tree Sir Hugh Beevor showed me forty-five years ago still flourishes, and that its present height is 45 feet, with a circumference of 3 feet 6 inches at 5 feet from the ground. The supposition that the tree is a hybrid of *Q. cerris* and *Q. suber*, which has produced such a remarkably fine timber, proves that we have been both idle and unenterprising, for in truth the wood of the Lucombe oak, if available, might have taken the place of foreign imports, and so released our shipping and increased our revenue. Little data exist upon which to base definite assertions; but the information we have goes to prove that this wood surpasses in

strength and durability more costly varieties that have been imported from abroad.

Elwes tells us that it is doubtful when *Q. Cerris*, or the Turkey oak, was introduced into Great Britain, but since neither Evelyn nor other authorities up to his time mention it, we may safely assume that its introduction dated from about two hundred years ago, when it became very popular throughout the south of England.

English landscape and parklands have a world-wide reputation, and one of the most noticeable and characteristic features is the Turkey oak, which has a grace and beauty all its own. As Elwes emphasizes, it grows not only faster but also straighter than other oaks, and although somewhat similar in appearance there is a subtle difference. The rugged dark-coloured bark first attracts attention, which is afterwards turned towards the noble crown, more widely spreading than the common oak and adorned with a richer green and jagged leaf. The tree produces a very pretty mossy-cupped acorn. The colour of the timber is similar to that of the common oak. It has a bad reputation among craftsmen, as it is harder and heavier to work and more inclined to split in seasoning. It contains a larger proportion of sapwood than the common oak, the outer line of which quickly perishes. The inner line, when carefully dried off, becomes as hard and durable as the heartwood. I am inclined to think that it has been used in the place of ordinary oak, and despite the difficulties already mentioned, I believe that with proper treatment it would be found as useful and durable as other kinds.

In Norway, Sweden and Finland, where the forest wealth plays a most important part in the economic life of the countries, I understand a day is set apart when men, women and children set forth to plant trees. For nearly two hundred years the people of England have enjoyed or been spoilt by a prosperity unequalled, if not unsurpassed, by any other country except America, which ominously reminds us of the state existing in the Roman Empire 1800 years ago. The contrast between the action of our forefathers, to whom we owe the inheritance of our woodlands, and later generations, is nowhere more clearly seen than in the direction of reafforestation.

I have been told that in the eighteenth century Admiral Collingwood used to walk out with his pockets full of acorns, which he distributed over his estate, and the owner of that country, which includes what is now called Chanctonbury Ring, used to ride or walk to the top of the hill every day during the season and sow beech mast or plant a tree.

No words of mine can better express the policy which should be adopted by the State to-day than those written by Evelyn 260 years ago :

"And if thus His Majesty's forests and chases were stored, viz. with this spreading tree at handsome intervals . . . benignly visited with the gleams of the sun . . . nothing could be more ravishing. . . . We should find such goodly plantations for the boast of our rangers, and forests infinitely preferable to anything we have yet beheld, rude and neglected as they are today, when his Majesty shall proceed, . . . to animate the laudable pride into fashion, forests & woods . . . will present us with another face, than now they do. And here I cannot but applaud the worthy industry of old Sir Harbotle Irmistone, who I am told from a very small nursery of acorns which he sowed in the neglected corners of his grounds did draw forth such numbers of Oaks of competent growth . . . and did wonderfully improve both the beauty and the value of his desmesnes."

TESTING WOOD PRESERVATIVES

An article by J. Leutritz (*Bell Lab. Rec.*, 22, No. 4 ; December 1943) describes laboratory and outdoor tests made on wood preservatives used for impregnating poles for communication lines. Sticks ¾ in. square and about 3 ft. long are cut from boards of southern pine sapwood, the uniform size of these samples facilitating calculation of the wood density and the amount of preservative retained, as both are based on volume.

Laboratory tests on preservatives are now carried out in an experimental cylinder by either full- or empty-cell methods. For the former, the air is evacuated from the cylinder containing the specimens, and after a specified time the cylinder is filled with preservative, air pressure being applied to force the latter into the wood cells ; about 30 lb. of preservative can be injected per cu. ft. of wood In the empty-cell treatment the cylinder air pressure is raised to from 25 to 50 lb./sq. in. Then the preservative is pumped in, and the pressure is raised still higher to force the preservative into the wood. Upon releasing the pressure, the expansion of the initial air trapped by the preservative forces out the excess from the wood, and theoretically only the cell wall is coated. Vacuum is applied after the pressure is released to empty the cells more completely. The initial air pressure largely determines the amount of preservative which will be forced out of the cells, while the difference between the initial and final pressures controls the distribution and penetration.

About twenty sticks are selected for each charge and the sample is weighed before and after treatment, the gain being taken as the basis for calculating the amount of preservative retained. Then the sticks are cut at the centre to give specimens treated under identical conditions for comparison by the laboratory rot test and by field exposures. For field-exposure tests the specimens are buried to a depth of 7 in. in a uniform distribution throughout the test plot. They are examined once a year and the amount of decay at and below the ground-line is rated. Since some specimens survive several years or do not fail under exposure tests, a time rating was devised which takes into consideration their past performance.

When a preservative shows promising results in laboratory and field tests, larger material of fence-post size and eventually 10 ft. posts are treated and exposed in 'test gardens'.

ELECTROSTATIC ELECTRON LENSES

An article by K. Spangenberg and L. M. Field (*Elec. Comm.*, 21, No. 3 ; 1943) describes and discusses the measured characteristics of a number of electrostatic lenses, giving the characteristic curves of nine different lenses belonging to three basic types. The forms tested were cylinder lenses of various spacings and diameter-ratios, aperture lenses (parallel plates with circular apertures on the beam axis) of various spacings, and, for comparisons, a lens formed by a cylinder and an aperture in a plate. By interpolating between the sets of curves given, approximate predictions of the properties of lenses of slightly different spacings or diameter-ratio may be made. The test method employed makes use of a

conventional electron-gun with parallel wire grids which, for measurement purposes, are placed before and after the lens to be tested. All the lens characteristics are deducible from measurements made on shadows cast by these measuring grids upon a fluorescent screen placed in the electron beam at a suitable distance from the gun.

The measured characteristics of the electron lenses are presented in the form of object-image distance curves termed p–q curves. These show the relation between object distance and image distance for any ratio of the voltages applied to the electrodes; they also show the lateral magnification associated with any combination of object and image distances. These curves are a graphical presentation of the complete solution of the lens formulæ and they give immediately and directly the relation between all quantities necessary for lens design. The p–q curves further show the interrelation between all the operating characteristics, the quantities involved being object distance, image distance, lateral magnification, and voltage ratio. The object distance (p) is the distance from some reference plane in the lens structure to the point from which the rays emanate. The image distance (q) is the distance from the same reference plane in the lens structure to the point on which the rays are focused. The lateral magnification is the ratio between the height of any corresponding portions of image and object. The voltage ratio is the ratio of potentials on the two components of the electrode structure calculated on the basis of zero potential at the point at which the electron velocity is approximately zero, usually at the cathode. It is only the ratio of potentials and not the absolute magnitude that is of importance, since electron paths are independent of the scale of the potential for the same starting conditions. For completeness, the lens characteristics are also presented in the form of the conventional focal distance curves which show the variation with voltage ratio of the two focal lengths and of the two focal points. All the image-forming properties of the lens may be deduced from these parameters.

FORTHCOMING EVENTS

Wednesday, April 12

Town and Country Planning Association (at St. Martin's School of Art, Charing Cross Road, London, W.C.2, in conjunction with the Exhibition "Reconditioning England"), at 3 p.m.—Mr. F. J. Osborn: "Preservation and Progress".

Institution of Electrical Engineers (Transmission Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. G. W. Preston and Dr. H. G. Taylor: "Copper Conductors for Overhead Lines".

Institute of Welding (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 6 p.m.—Dr. L. Reeve: "Factors Controlling the Weldability of Steel".

Thursday, April 13

Genetical Society (at the Linnean Society, Burlington House, Piccadilly, London, W.1), at 11.30 a.m.—Symposium on "The Application of Genetics to Plant and Animal Breeding".

Institution of Electrical Engineers (Installations Section) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. C. A. Cameron Brown: "The Electrical Aspect of Farm Mechanization".

Friday, April 14

Institution of Chemical Engineers (at the Connaught Rooms, Great Queen Street, London, W.C.2), at 11 a.m.—Twenty-second Annual Corporate Meeting; at 12 noon—Mr. F. A. Greene: "Our Title—a Reminder" (Presidential Address); at 3 p.m.—Mr. J. G. Bennett: "Coal and the Chemical Industry" (First J. Arthur Reavell Lecture).

Society of Chemical Industry (Plastics Group) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2.30 p.m.—Symposium on "Electrical Properties of Plastics" (Mr. H. A. Nancarrow: "A Survey of Thermal Plastics as Dielectrics"; Dr. L. Hartshorn: "The Principles of High Frequency Heating"; Mr. E. Rushton: "Tracking").

Royal Anthropological Institute (joint meeting with the International African Institute) (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Mrs. G. M. Culwick: "Nutrition in East Africa".

Royal Astronomical Society (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. E. A. Milne, F.R.S.: "On the Nature of Universal Gravitation".

North-East Coast Institution of Engineers and Shipbuilders (at the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—General Discussion on "Radiological Testing" (Speakers: Sir Lawrence Bragg, F.R.S., Dr. S. F. Dorey, Dr. V. E. Pullin, Dr. H. Harris).

APPOINTMENTS VACANT

Applications are invited for the following appointments on or before the dates mentioned:

Master for Mathematics and Science—The Clerk to the Governors, North-East Essex Technical College and School of Art, Colchester (April 11).

Waynflete Professorship of Metaphysical Philosophy—The Registrar, University Registry, Oxford (April 13).

Lecturer for Degree and National Certificate subjects in Mechanical Engineering—The Organizer of Further Education in Rugby, College of Technology and Arts, Eastlands, Rugby (April 14).

Laboratory Steward in the Science Department of the Doncaster Grammar School—The Chief Education Officer, Education Offices, Doncaster (April 15).

Research Worker (who should be a Physicist with some research experience) in the Coal Treatment Laboratory of the Mining Department—The Secretary, The University, Edmund Street, Birmingham 3 (April 15).

Lecturer (preferably a woman) in Biology—The Warden, Goldsmiths' College, at University College, Nottingham (April 15).

Assistant Hydrographic Surveyors by the Kenya Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E 904A) (April 15).

Principal of the Yeovil Art and Technical Institute—The Chief Education Officer, County Hall, Taunton (April 15).

Headmaster of the Junior Technical School—The Chief Education Officer, Education Offices, Doncaster (April 15).

Graduate Assistants (full-time) for Mechanical Engineering, Electrical Engineering, and a Graduate (or equivalent qualification) in Building or Structural Engineering, at the Darlington Technical College and Technical School—The Chief Education Officer, Education Office, Darlington (April 15).

Teacher (full-time) of Engineering Subjects, including Electricity—The Principal, Technical and Art Institute, Queen's Road, Watford, Herts. (April 17).

Assistant (full-time) to teach Workshop Practice, Engineering Drawing, Mathematics and Engineering Science, at the Jarrow Technical School and Evening Institute—The Director of Education, Shire Hall, Durham (April 19).

Senior and Junior Engineers (Mechanical and Electrical) to carry out work of national importance in a Government Department (location, London)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2097A) (April 22).

Research Metallurgist, preferably with knowledge of Engineering, by well-known North Country firm specializing in the Use and Heat Treatment of High-Carbon and Alloy Steels—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2019XA) (April 29).

Professorship of Engineering Science—The Registrar, University Registry, Oxford (April 30).

Lecturer (full-time) in Chemistry at the Cardiff Technical College—The Director of Education, Education Offices, Cardiff (May 1).

Chair of Philosophy at the University of the Witwatersrand, Johannesburg—Dr. William Cullen, 4 Broad Street Place, London, E.C.2 (May 1).

Director of the Institute of Medical and Veterinary Science, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

Chair of Natural Philosophy, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

Lecturer for Biology and Hygiene—The Principal, St. Katharine's College, Tottenham, at Cary Park, Babbacombe, Torquay.

Lecturer in the Junior Technical School (subjects: Mathematics, Science, Drawing)—The Registrar, Technical College, Cheltenham.

Senior Science and Mathematics Master—The Headmaster, Alleyne's Grammar School, Stevenage, Herts.

Designing Engineer for the Steel Tube Trade in Birmingham—The Ministry of Labour and National Service, Appointments Office, 2 Calthorpe Road, Birmingham 15 (quoting Reference No. 1368).

Assistant Mechanical Engineer for the Sudan—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1302).

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Standard Recommendations for the Storage of Micro-Film (British Standard 1153—1944.) Pp. 6. (London: British Standards Institution.) 1s. [143

Town and Country Planning Association. Forty-fifth Annual Report. Pp. 8. (London: Town and Country Planning Association.) [143

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SOCIAL MEDICINE

THE conception of social medicine, which has been the subject of several recent addresses by leading medical men, was, as Prof. Major Greenwood has pointed out in a Chadwick Lecture (*Lancet*, March 13, 1943, pp. 325–328), inherent in the teaching of Hippocrates. In those early days the training of the medical student was a much more personal matter than it is to-day. The student studied with his master, much as he did in the days of our grandfathers; he learned, as medical students of a century ago still did, much about the mode of life of his patients; and medical opinion is nowadays rediscovering the value of this method of approach. It is coming into line with the similar recent movement among biologists, who have learnt that the organisms which they study cannot be fully understood unless they are studied as beings which are inseparable from the surroundings in which they live. It is being recognized by medical men that the individual human patient must indeed be studied as an individual; sympathetic insight into his peculiarities is as important as, and sometimes more important than, knowledge of the malady from which he is suffering; but the group to which he belongs must also be studied, and also all the conditions which civilization imposes upon both the individual and the group. It is the task of social medicine to study such problems as these. Their variety and importance have recently been emphasized by Prof. J. A. Ryle (*Brit. Med. J.*, Nov. 20, 1943, p. 633), who is professor of social medicine at Oxford and head of the first Institute of Social Medicine to be established in Great Britain. A similar department has recently been created by the University of Birmingham, and it would appear that the University of Edinburgh is moving in the same direction with the appointment of Prof. F. A. E. Crew to the chair of public health (see NATURE, March 25, 1944, p. 371).

Social medicine is not, in the opinion of Prof. Ryle, just another name for preventive medicine, and it is not socialized State medicine. It embodies the idea of medicine applied to the service of man and of the community, and seeks to lower the incidence of preventable diseases and to raise the general level of fitness. It lays emphasis on those causes of disease which are rooted in the environment, and so is directly related to social work of all kinds.

How much has already been done in this direction has been indicated by Sir Wilson Jameson, chief medical officer to the Ministry of Health, in his Harveian Oration to the Royal College of Physicians (*Lancet*, Oct. 24, 1942, p. 475). He showed there how profoundly the development of medicine has been influenced by the great social changes which have occurred since the Industrial Revolution, and also how great has been the stimulus given to this development by war. The beneficent work begun by Florence Nightingale has led us far beyond the betterment of the lot of the fighting men. The pages of the medical journals show how much has been

done for the people in general by such means as mass radiography, industrial health schemes and, during the present War especially, by the national food policy, which is based upon recent discoveries in the science of nutrition.

That much more can be done no reasonable man will doubt. Prof. Sargant Florence (Nature, March 25, 1944, p. 363) has put forward some valuable suggestions for the study of variations in human health and efficiency with living and working conditions. Prof. Ryle tells us something of what is already being done at Oxford. He urges us to get away from the specialism and reliance on technical procedures which have been so marked a feature of medicine during the last quarter of a century. As the *British Medical Journal* (Nov. 20, 1943, p. 648) points out, we have taught medical students to think too much about how men die and too little about how they live. We should consider the patient more as an individual inseparable from such environmental factors as the anxieties of a job and a home, economic insecurity, the fear of poverty, and from ignorance of how to live a healthy life and how to use leisure. The importance of such root causes of disease as these has been emphasized by Dr. Geoffrey Bourne in a Penguin Special, "Health of the Future" (1942). Dr. Pemberton (*Brit. Med. J.*, Dec. 11, 1943, p. 754) and Dr. Lloyd-Davies (*Lancet*, Feb. 12, 1944, p. 223) discuss the same theme. Since the War began, Scotland has, with the aid of the Emergency Medical Service hospitals, tried experiments in social medicine. These are described in "Health and Industrial Efficiency: Scottish Experiments in Social Medicine" (London: H.M. Stationery Office, 1943. 1*s*.). These social causes of disease are, as Prof. Ryle points out, being studied in the United States, India, the British Dominions and in the U.S.S.R., and we can learn much from these countries. There is certainly no lack of material for such beneficent work.

Tuberculosis, venereal disease, cancer, rheumatism, influenza, typhoid and other fevers and the blindness which afflicts, as Prof. A. Sorsby points out, some fifteen million people in the world (*Brit. Med. Bull.*, 1, No. 9; 1943; see Nature, March 25, 1944, p. 383) all come within the scope of social medicine. Nor must we think that, when the causes of disease lie in the environment, it is always the ugly and distressing features of that environment that are responsible. Disease may arise, as endemic goitre does, from some feature of the most delightful rural surroundings. The Goitre Sub-committee of the Medical Research Council, in its memorandum on this particular disease (*Lancet*, Jan. 22, 1944, p. 107), recommends, as a national policy, the addition of one part of potassium iodide to one hundred thousand parts of common salt, as a prophylactic, comparable to our national measures against deficiencies of proteins, vitamins and other essential elements in our diet. There are, further, the diseases which do not always kill, but cause incalculable disability, unhappiness and economic loss. An example of these is gastric ulcer, which is increasing greatly; it affects all social groups; it attacks certain temperamental and physical types more than others; it is, in Prof. Ryle's words, a disease of our era of money-getting and money-lack, of occupational and domestic anxiety, of restless living, snack meals and excessive tobacco consumption. It could become as rare as it used to be, if its root causes, which are largely economic, were so fully understood that they could be removed.

It is clear, therefore, that social medicine has a great part to play in social reconstruction after the War. It is clear, also, that the medical student, as well as the qualified medical man, will have to take an active part in this work.

The report of the Royal College of Physicians on social and preventive medicine (see *Brit. Med. J.*, Oct. 30, 1943, p. 553) lays down the lines of a possible future development of social medicine. This report avoids the addition of social medicine as merely another special study tacked on to the existing curriculum. It suggests a modernized course in social and preventive medicine, which should be founded, as the clinical subjects are, on the basic sciences, and should grow and expand through the three clinical years. It should, moreover, be a practical course, operated by a Department of Social and Preventive Medicine in every medical school and should replace the present courses in public health; it should also bring the student into close touch with the active social organizations in the community concerned, especially with the health services provided by the local authorities and with the hospital almoner's department. All medical schools should recognize the importance of problems of industrial medicine; student health services should be available in every medical school and should be used as the instruments of teaching. All hospitals should employ properly trained almoners and psychiatric social workers for the teaching of students as well as for the care of patients; and the Royal College of Physicians should take an active interest in the organization of the teaching of social and preventive medicine, not only to medical students but also to nurses and medical social workers.

The adoption of these admirable recommendations would mean that medical students would learn in a practical way the social and industrial factors which contribute to disease; they would learn methods of social investigation; they would learn all about existing social organizations; they would be able to undertake that admirable mission which Prof. Ryle prescribes for them, the mission of helping, with the aid of their scientific associates and of social workers, to expose social evils and to devise means of removing them. In this way the medical practitioner of the future would fulfil, in a wide and modern sense, the traditions of a profession which was, to the fathers whom we remember, the noble calling of friend and counsellor as well as mender of physical and mental ills. Such a calling will require and will attract the best type of woman and of man. Its teaching and research facilities should be endowed and assisted to the fullest limit of our capacities, so that they may be intensified and expanded to meet the manifold requirements of the post-war world.

INTRODUCTION TO GEOLOGY

Geology for Everyman

By the late Sir Albert Charles Seward. Pp. xi+312+8 plates. (Cambridge : At the University Press, 1943.) 10*s*. 6*d*. net.

BOTANIST, geologist and lover of Nature and of his fellow-men, Sir Albert Seward finished writing this book three days before his sudden death. It was evidently a labour of love—this endeavour to transmit to others his enthusiasm for the only real open-air science. Not only is the book an appeal to folk to take up geology as a hobby, but also it sets out "to present a case for the inclusion of an intelligent interest in" the subject "as part of that intellectual equipment we call culture, culture that has been defined as what remains after we have forgotten all we learnt at school". His descriptions "are not intended to serve as an elementary text-book" ; his "hope is that they may be used as stepping stones to something higher and more scientific".

Such a book has long been needed, for geology has receded from the position it held a century ago as part of the natural equipment of an educated person. To-day its principles are little understood, and its discoveries and their implications are ignored. Perhaps people are put off by the scientific jargon which prevails in geology to an undue degree ; but Seward's book proceeds in the first few chapters with many delightful personal touches to arouse an interest in the basic principles of the science with a minimal use of technical terms, though he pleads that "some of the technical terms in common use by geologists should find a place in the vocabulary of all educated people". It is perhaps questionable whether the bare minimum of principles given here will by itself provide a complete novice with sufficient knowledge to take the fullest advantage of the main part of the book which follows. This is devoted to the record that the rocks provide of an ever-changing geography brought about through the slow grinding away of land, and the growth of deltas, plains and mountains through the ceaseless movement of the crust and the equally inexorable changes of climate. Throughout, Seward uses the changing geographical scene as the background to organic evolution.

It is natural that the author of "Plant Life throughout the Ages" and of the standard text on "Fossil Plants" makes evolution one of the main themes of his book, with particular emphasis on the changes in plant life from age to age. As this is an aspect of the stratigraphical record to which Seward had devoted his life, and one that rarely receives adequate recognition in geological text-books, the treatment is rightly developed on a fuller and more satisfying scale than that accorded to the animals, though their palæontological record is not neglected. General readers for whom the book is intended will be attracted to the study of fossils through the clear way in which their significance is brought out.

The method adopted in this book of treating the geological periods from the newest to the oldest has the sanction of authority in that it was used by Lyell ; but it inevitably leads to repetitions, some of which are irritating and tend to distract from the sequence of the events. But in this book each chapter is an exposition of one or two major principles or important incidents rather than a description of an ordered cavalcade of events. Doubtless Seward intended to excite interest in some particular part of the geological record and to show what sort of things can be deduced from it, and for this purpose was not over-concerned with its dating. Here are some of his themes : Britain under the arctic conditions of the Ice Age, post-Glacial climatic changes and their effects on the vegetation, de Geer's system of geochronology, the changing floras of the Tertiary and their interpretation in terms of climate, the building of the Alpine chain, the break in mid-Cretaceous times between ancient and modern types of plants, the salt lakes and deserts of the New Red Sandstone, the origin of coal, the value of careful fossil collecting and the contribution to science that it can make even in the hands of amateurs.

The chapters relating to the Cretaceous, Tertiary and Glacial periods are very interesting and attractively written, and so are the ones on fossils ("Medals of Creation") and on the "Procession of Life" ; but strangely enough the one on the origin of coal is disappointing and surprisingly misleading over the composition of that much-analysed substance. Naturally the older formations are more difficult to deal with ; but a sense of their influence on scenery, their antiquity and of the strangeness of the forms of life that they contain, is vividly conveyed. "The world, to our limited vision, appears to be almost static ; mountains we have thought of as symbols of eternity, seen through geological spectacles, take their place as episodes in a series of events which have moulded the changing features of the earth's face. The rocky covering of the world viewed by geologists, 'foreshortened in the tract of time', reveals itself as a dynamic mobile crust responding from age to age to constructive and destructive forces which have operated since the earth's early youth."

This is a book so full of wisdom, wit and learning that it cannot fail to convey to its readers the author's lifelong enthusiasm. For this reason alone it is particularly welcome to-day, for it will take an honoured place among the instruments designed for that wider education of young people and adults which we all look forward to after the War. It will find its most appropriate niche in the school library and on the bookshelves of students' hostels, clubs and unions ; but it should also make a strong appeal to lovers of the country and to the not inconsiderable number of persons who like 'to go geologizing'.

L. J. Wills.

PLANT GEOGRAPHY OF THE MEDITERRANEAN REGION

Das Pflanzenkleid der Mittelmeerländer

Von Prof. Dr. M. Rikli. Lieferung 3. Pp. 241–352+13 plates. Lieferung 4. Pp. 353–436+14 plates. (Bern : Hans Huber, 1943.) 9 Schw. francs each.

THE publication of another two serial parts of Dr. Rikli's book on the plant cover of the Mediterranean region completes volume 1 of this work (for an account of the first two parts see Nature, 152, 117 ; 1943). Part 4 includes the title-page and list of contents of the volume, together with a short preface by the author. In the latter it is noted that the large number of maps showing the geographic distribution of numerous different species in the region have been prepared on the basis of the classical floristic works and partly in consultation with specialists on certain parts of the Mediterranean basin. The advantage of these maps is the rapidity with

which a general impression of the distribution of a species may be obtained; but on the other hand, they tend to imply a completeness of knowledge which is not actually existent, and gaps within the total area of distribution are as a rule disregarded. Their primary object is to serve as a stimulus for the collection of further data, so that in a later edition the maps may be supplemented or corrected as is found necessary, and communications on this subject are invited by the author.

The seventh chapter, dealing with the natural land of the cultivable belt, is now completed, and the eighth chapter, which studies the distribution by altitude of the various formations discussed, brings the first volume to a close. A note at the end of the seventh chapter states that the cultivated land is to be treated in Chapter 10. The normal disadvantage of any such serial publication, namely, that some illustrations to which allusion is made or pertinent references to the literature have not yet appeared, although it certainly exists in the present case, is not so serious as to be of any significant hindrance to the use of the work.

The natural formations described in the remainder of the seventh chapter comprise large-shrub formations, the xerophilous small-shrub formations, tracts of herbaceous growth and of tall herbaceous, large-leaved plants, and sea-shore, dune, lakeside, marsh and cliff formations of various kinds. Under the first-named the section on the pseudo-maquis is terminated, and the sibljak formation is described. The sibljak is a sub-Mediterranean association of summer deciduous therophytic shrubs or shrub-like trees which are able to bear—in addition to a dry, hot summer—a fairly severe winter with occasional low temperatures, cold winds, and often also a long covering of snow. It is never found near the coast, but principally in the more continental part of the eastern Mediterranean, although it is recorded also for the west, for example, the centre of the Iberian peninsula. Some fifteen to twenty species participate in the structure of this formation, which is generally seen above the evergreen level and is considered in many localities, such as steep rocky slopes, scree on slopes, etc., to be an original association, the area of which has become greatly enlarged, however, through the destruction of forest.

The xerophilous small-shrub formations described are the steppe of succulents and thorn bush limited to southern Morocco, the ericaceous heaths—in the Mediterranean a type of vegetation principally of the submontane level, and in the Iberian peninsula of unusual richness—and the garigues. The name 'garigue' is of Provençal origin, and is applied to a more or less open association of small shrubs, seldom higher than 1–1·5 metres and often rich in ethereal oils. Between maquis and garigue all manner of transitional formations exist. Sixteen different types of garigue are distinguished and described. Their use for grazing is generally very intensive, as a result of which many plant species become eliminated in the course of time, while others, such as certain thorn bushes and especially poisonous plants (*Peganum Harmala*), become dominant. Where the humus-deficient soil of the garigues becomes still shallower and dries up more rapidly, even the small shrub growth is endangered, and its place is gradually taken by an ephemeral growth of therophytes and by geophytes. This formation is described as 'herbaceous grazings (rock grazings)', the word 'Trift', which means a pasture or grazing, being used in preference to 'Heide' or 'heath' in order to avoid confusion with the ericaceous formation. The word indicates, too, the only use—periodic grazing—to which these lands are put. Typical of the formation is its great abundance of species and their magnificent colouring when in flower. A different type of vegetation is seen in the association of tall, large-leaved herbaceous plants, 1–2 metres and more in height, found in moister, better soils of (*a*) forest regions and (*b*) in open association in dry regions.

In the consideration of the strand and marsh formations there are treated successively the submerged associations; the sparse vegetation of the strand itself; the vigorous plant-growth found amid heaps of large rocks, which is quite different from that of similar rock groups in the mountains; the vegetation of the littoral shifting-sand zone and of the littoral dunes respectively; that of the salt marshes, the freshwater marshes, of ponds (depressions only periodically flooded and dry for practically the greater part of the year), lake- and river-sides; and finally, the cliff and strand rock flora affected by surf and spray. Dunes are found on all the flat coasts of the region, but especially along the Atlantic coasts of the Iberian peninsula and Morocco (Agadir and Mogador) and on the shores of the Sirte region in northern Libya. Successful efforts at the stabilization of dunes between Tripoli and Lebidah (also named Leptis Magna or Neapolis) are described. In regard to the river- and lake-side flora, it is noted that boreal species form the main contingent of the plants present; specifically Mediterranean elements are rare, and it is almost the papyrus alone that is of definitely southern origin.

The classification of the Mediterranean plant cover in accordance with altitude is impeded by the fact that the various levels are not so sharply defined as in central Europe, and the actual elevation at which associations or their components are found varies very considerably with the region. This is discussed with particular reference to the evergreen, Mediterranean culture belt as found in the Iberian peninsula, Corsica, the Apennine peninsula, the northern part of the Balkan peninsula, Greece, the Near East, and the Atlas lands respectively, and it is concluded that, generally speaking, the limit of the altitude line or belt becomes higher from north to south and lower from west to east. Allowance being made for variation of this nature, three more or less clearly defined altitude lines or vegetation belts ('Hohenstufen') are distinguished, namely, (1) the evergreen, Mediterranean culture belt (also described as the olive girdle or, from its most important formation, the maquis girdle); (2) the Mediterranean mountain belt, embracing the region from the upper limit of the evergreen belt to the upper forest- and tree-line; and (3) the orophytia belt. Of the first, the natural land formations have already been described in the seventh chapter, and reference is made to Chapter 10 (not yet published) for those of the cultivated land. A description of the second belt occupies the major part of the eighth chapter, and discussion of the third is reserved for a further section.

Originally the Mediterranean mountain belt consisted for the most part of forest, but the spoliation of centuries has led to far-advanced deforestation in many parts, where the place of the woods has been taken by impoverished, grazed garigues. In other parts, however, the woods remain and present a constantly changing landscape made up of different kinds of trees. The influence of the forester is as yet

insignificant. The woods are composed either of deciduous trees, especially *Castanea sativa* and *Fagus silvatica*, occasionally also *Quercus Ilex*, or of a large number of conifers of the genera Picea, Pinus, Abies, Juniperus, Cedrus and Cypressus. The distribution and nature of these woods and their components are described in considerable detail.

Finally, there are described the formations which have possessed themselves of the areas denuded of forest. Of these the most important is the garigue, the capacity of which for establishing itself on such lands exceeds that of any other formation. Not only does it occupy wide tracts of the former woodland girdle, but also it often reaches far above the upper limit of the Mediterranean forest- and tree-line.

G. M. ROSEVEARE.

A SURVEY OF PLANT DISEASE

Report on Fungus, Bacterial and other Diseases of Crops in England and Wales for the Years 1933–1942

(Ministry of Agriculture and Fisheries, Bulletin No. 126.) Pp. iv+100+8 plates. (London: H.M. Stationery Office, 1943.) 2*s*. net.

IT is sometimes a little difficult to attain true perspective in a science like plant pathology, where facts are accumulated in a manner necessarily fragmentary and sporadic. Diseases never occur in standard measure, either of space or time, and Pasteur's dictum that chance favours only the mind that is prepared applies with special emphasis to the study of plant pathology. It is very appropriate that a periodical review be made of the occurrence of all diseases, and Mr. Moore, who is mycologist to the Ministry of Agriculture and Fisheries, has gathered together such information for England and Wales. He has had numerous collaborators, and the review follows an earlier bulletin (No. 79) which covered the five years, 1928–32.

One of the outstanding indications of the bulletin is the increasing number of plant maladies which are now recognized. This is, in all probability, due to the fact that cultivators are now more aware of diseases than formerly. We are separated by little more than half a century from the time when blights upon crops were regarded as 'acts of God', as little amenable to control as the whirlwind. The increasing tempo of plant cultivation since the outbreak of war has brought the plant pathologist much extra work, but has also given him a further harvest of scientific facts. Moreover, such glances as are vouchsafed into what might be called the archæology of plant pathology show that diseases were often present on fragments of plant material preserved from bygone times. Greater awareness of disease is also shown by the increasing number of deficiency troubles which are included in the bulletin under review. The work of the pathologist here merges with the activities of the physiologist, with ultimate advantage to both.

The bulletin arranges the diseases of each host according to the nature of their causal agents, and in the order fungi, bacteria, viruses and non-parasitic. Pathology of ornamental plants, of hop, mushroom and flax, and of fruit and vegetables is recorded, in addition to the maladies of all farm crops. An indication of the thoroughness of compilation is given by the mention of Pythium root rot and a mosaic virus on watercress, the notice of *Ovularia Nymphærum* on water-lily, and a description of soft shell of the walnut; and diseases of the more usual crops receive no less encyclopædic treatment. Symptoms of the more recently discovered troubles are given in sufficient detail for field diagnosis, and some are illustrated in the eighteen excellent half-tone figures. Common names are in accordance with those recommended in the "List of Common Plant Diseases" of the British Mycological Society. The review certainly achieves the purpose of keeping the plant pathologist up to date.

Some effort has been made to correlate the incidence of disease with climate. Synopses of the weather in each of the ten years are given, and in some cases broad conclusions are possible. The general effect of weather on potato blight has been recognized for some time. Hot, dry summers in 1921, 1929, 1933–35 and 1940 rendered blight of little economic significance as a foliage disease. Wet and sunless periods between June and September in 1926, 1931, 1936 and 1942 brought very severe attacks of blight. A wet May seems to portend a bad year for apple scab, and abnormal rainfall in July and August renders the downy mildew of hops very destructive. Chocolate spot of broad beans can assume epidemic proportions in periods of dull, showery weather between April and July. Mr. Moore very rightly points out the need for more extensive and intimate studies of the 'micro-climate' within an infected crop. Closely connected with climatic survey is the question of estimation of disease intensity, and here the excellent pioneer work of the British Mycological Society is incorporated in the bulletin.

The incidence of wart disease is interesting. Its spread during the last twenty years has been greatly reduced by the operation of the Wart Disease of Potatoes Orders. Outbreaks since 1933 have averaged about 87 per year, and this figure has not been exceeded by the average for the war years. Onion smut, another disease subject to legislation, appears to be increasing, though it is probable that most of the new cases represent long-standing infection; they were discovered during an intensive survey by the Ministry's inspectors. The problem is complicated by the length of time the fungus can remain infective in the soil—at least seventeen years. A slight decrease in the amounts of severe mosaic and leaf roll is recorded in potato crops raised from new Scotch or Irish seed during the war years. There is also less virus infection in crops raised from once-grown seed. The bacterial disease mentioned most frequently is crown gall (*Bacterium tumefaciens*). It occurs upon such widely varying hosts as dahlia, raspberry, apple, vegetable marrow, tomato, mangold, chrysanthemum and many others. Of deficiency diseases, that of potassium appears to be most frequent, and most cases are reported in the war years. Magnesium, boron, manganese and calcium may also cause their respective deficiency symptoms. One type of injury likely to be recognized more widely in the future is that due to acid soil. Plants growing at the lower limit of their *p*H range frequently exhibit characteristic symptoms, and their tabulation is one of the future tasks for the joint efforts of plant pathologists and physiologists.

The bulletin is far more than a list of plant diseases. It is an informative conspectus of the intelligence section of phytopathology. Mr. Moore frequently uses a somewhat conversational blend of history and etiology, so that his descriptions are not merely arid records, and his pages often indicate the direction which future investigation should take.

JOHN GRAINGER.

BIOLOGICAL CONTROL AS A SUPPLEMENT TO CHEMICAL CONTROL OF INSECT PESTS

By DR. W. E. RIPPER
Pest Control Ltd., Cambridge

WHILE chemical control is in general the most effective method of pest control known and therefore the most generally used, an increasing amount of experimental proof has accumulated during recent years showing that this method has a very serious limitation. Repeated applications of chemical control result in an unintended artificial selection of those mutants within the pest population which happen to be resistant to the poison used. The progeny of these surviving mutants develop races of the pest which are more difficult to control than the general population.

This disturbing phenomenon was first noticed by Melander in 1914 on San José scale, *Aspidiotus perniciosus* (Comst.)[1]. Fifty years after the importation of this pest into the United States it was found that, after several treatments with lime sulphur had been carried out every year in the State of Washington for twenty-five years, this scale insect had become much more resistant to lime sulphur.

Next, Quayle in 1916[2] showed that a strain of the red scale, *Aonidiella aurantii* (Mask.), at Corona in California, was more resistant to cyanide fumigation than the general population of this pest elsewhere. Since the introduction of tree fumigation in 1886, prussic acid has given unusually effective control over a large part of the red scale infested area of California, but in certain districts, an increased resistance was found a few years previous to Quayle's publication in 1916. For more than thirty years the increase of the distribution of the resistant strain has been observed and the phenomenon extensively investigated by Quayle during 1916[2] and 1938[3] and Woglum in 1925[4], who established that the survival in areas where the non-resistant strain abounds was of the order of 1 per cent, while in the area where the resistant strain had developed it was 20 per cent. As the red scale has under present spraying schedules at least three generations to one treatment, such a difference in survival was of high economic significance, and the difference in susceptibility was noticed by the fumigation contractors operating in that area. Environmental influences were excluded by rearing sixty generations of colonies of the resistant and non-resistant races under identical conditions, when it was found that the same differences in susceptibility towards cyanide persisted.

Dickson in 1940[5] was able to show that the factor of resistance is inherited and situated in the *X*-chromosome and is therefore sex-linked.

From the general aspect of chemical control, it is important that the resistant strain of the red scale was also found to be less susceptible to two other fumigants, methyl bromide and ethylene dioxide.

Increased resistance to prussic acid was established for two further citrus scales, namely, the black scale, *Saissetia oleae* (Bern.)[2], and the citricola scale, *Coccus pseudomagnoliarum* (Kuw.)[3]. The spread of the resistant strain of the latter scale was dramatic in its rapidity; the resistant strain was first noticed in *one* orchard in 1936; but in the next three or four years the area of its distribution extended over most of the region infested by the citricola scale in Southern California. As natural barriers cross this area, the selection of this resistant strain must have occurred simultaneously from independent mutants. Thus in a very short period the effect of chemical control had changed from satisfactory to very unsatisfactory results.

Race segregation resulting from the application of insecticides is not confined to scale-insects but has also been found in the codlin moth, following treatments with arsenate of lead. The discovery of resistant strains as a result of chemical control on so different a type of insect first attracted attention to the general character of this sequel to chemical control. The most resistant strain was found in Colorado, where codlin moth had appeared in 1891, and spraying with arsenate of lead had been started three or four years later. In 1900 two sprays were necessary to obtain a satisfactory control, and by 1930 eight, ten or twelve.

This resistant strain was investigated by Hough[6,7,8], who took a stock of the codlin moth from Colorado to his laboratory in Virginia and studied it there in comparison with the endemic codlin moth population. It was found that the Colorado strain was not only able to enter apples sprayed with arsenate more successfully than the Virginian strain, but also showed the same superiority in its resistance to other spray residues, such as cryolite, barium fluosilicate, rotenone, nicotine, cuprous cyanide. The Colorado strain was also significantly resistant to cyanide fumigation in the incubated-egg stage and in the larva stage.

Hough was further able to demonstrate that a strain with similar characteristics to the Colorado strain can be bred from the Virginian codlin moth populations by artificial selection. He held the opinion that mutants of the same higher resistance existed in all codlin moth populations.

On a very different type of insect, the larva of the primary screw worm, *Cochliomyia americana*, Knipling[9] was able to demonstrate that a greater resistance against phenothiazine could be acquired and inherited.

Increased resistance against tartar emetic sucrose bait has been noticed in the Citrus thrips[10]. An interesting feature of this case is the development of a resistant strain after this spray chemical had been used for three or four years only. Resistance developed in a fairly big area over a space of about a hundred miles with big stretches of uncultivated land and mountain barriers between, so that it would seem that mutants may have arisen at several foci simultaneously.

Thus, in the life-time of one entomologist at least seven species of injurious insects have evolved races which are more resistant to certain insecticides than the ordinary populations or any of the populations of twenty-five years ago.

In some cases the resistance is not specific towards one chemical but results in the pest being more difficult to kill by a whole range of chemicals, so that it seems that the segregation of these new resistant races is a problem of rapidly increasing importance and far-reaching effect on our conceptions of chemical control. If it is remembered that, as the above described facts show, this increasing resistance can be acquired in a period of repeated applications of chemicals varying from three or four to thirty years, it is not difficult to appreciate the concern of the entomological profession over this man-bred segregation which renders the pests more and more inaccessible to our control measures.

The position has been admirably surveyed by Harry

Smith[11] and Quayle[12] in its genetic, entomological and economic aspects, and Smith concluded that the segregation of resistant races "is an obstacle to the practical usefulness of entomology, the surmounting of which will require not only all our ingenuity, but all our capacity to organise and ability to enlist the active co-operation and interests of geneticists, physiologists, ecologists, and taxonomists. It is my firm conviction that recognition of the practical significance of the effect of man's activities on the racial composition of insect populations, followed, of course, by group attack for solution of the problems arising from it, will become a milestone in the progress of both the science and the art of applied entomology".

As the segregation of resistant races is caused by the survival of resistant individuals, it seems expedient to direct our attack against these surviving resistant mutants. As shown by Hough[8] and Yust[13], the latter may possess a higher resistance against a variety of chemicals; it seems, therefore, obvious that the reduction of these survivals must be attempted by a totally different method, for example, by biological control. For this purpose, we require an insecticide which would kill a much greater proportion of the pests than of the predators and parasites of the pest. Such an insecticide is referred to in the following as a *selective insecticide*. In such a case the surviving beneficial insects should clear up the resistant mutants of the pest before the latter can propagate and develop a resistant strain. In other words, we are searching for a type of insecticide capable of effecting a shift of the oscillatory equilibrium between the population of the pest and the population of parasites and predators in such a direction that the latter outnumber the former, either immediately or in a short interval after spraying, and lead to a complete annihilation of the pest population in the treated biotope.

The development of selectively poisonous chemicals would not only enable us to prevent segregation of resistant strains, but would also be desirable for economic reasons. Many treatments with insecticides lead only to relief from the pests for the time being, because immediately after treatment the pest population builds up quickly and necessitates a repetition of the treatment, often, during the growing season, within ten days or a fortnight.

In many cases it has been observed that the re-infestation after chemical treatment builds up more quickly than the original infestation. The theory underlying this phenomenon was described by Volterra[14] in his consideration of the variations and fluctuations of the number of individuals in two animal species living together, one species preying on the other, and was communicated in what he called the "Law of the Disturbance of Averages": "If an attempt is made to destroy the individuals of two species uniformly and in proportion to their numbers, the average of the number of individuals of the species that is eaten increases and that of the individuals feeding upon the other diminishes". Hence the destruction of a whole section of the population of hosts, predators and parasites may result in a subsequent relative increase of the host and relative decrease of the parasite, a phenomenon only too familiar to all entomologists engaged in pest control operations, as a frequent sequel to chemical control. Such deleterious effects of spray treatments on the parasites of the pests has often been recorded (Driggus & Pepper[15]; Driggus & O'Neil[16]; Boyce[17]).

If the chemical control necessitates a repetition of the treatment, it is obvious that the application of the method will only be an economic proposition on higher paying crops. The use of selective insecticides, apart from preventing the segregation of resistant strains, will also reduce the number of spray operations necessary and thus bring pest control methods within reach of growers of cheaper, that is, farm, crops.

All these limitations of chemical control as practised to-day make the introduction of selective methods of pest control highly desirable.

Some attempt has been made to develop such selective insecticides by utilizing the differences in the physiology of the phytophagous insects on one hand and the carnivorous or parasitic insects on the other hand. For this purpose, stomach poisons were prepared, the individual particles of which were coated with substances digestible only by certain groups of phytophagous insects. By this means the poison was rendered indigestible to adult Hymenoptera and certain other insects and therefore harmless to parasites and certain predators[18].

Another attempt towards selective eradication of pests was based on the difference in toxicity of nicotine vapour to aphides and parasites or predators. It can be shown that short exposures of 40 sec.–1 min. to nicotine vapour at a temperature of 60°–80° F. and of a concentration of 0·8 mgm. per litre, proves fatal to 80–99 per cent of certain aphides, but does not seriously affect coccinellids, syrphids or the larvæ of the Braconid aphid parasite Aphidius, which lives and pupates in the aphides.

These beneficial insects surviving the nicotine vapour treatment outnumber the surviving aphides and decimate the latter in the weeks following the treatment, so that after an initial high percentage of kill, the infestation is further reduced. Thus, this method gives the best control of aphides hitherto demonstrated on farm and market garden crops in Great Britain, and has therefore been used on a large commercial scale during the past four years. It is called field fumigation or gassing.

The method fulfils all requirements postulated earlier for a selective insecticide, and a quantitative study of changes in the population of the pest and its natural enemies caused by the selective action of insecticide is therefore of general interest in ascertaining the mechanism of the combined action of chemical and biological control, and more especially to determine whether the limitations of chemical control as generally practised are overcome.

While the destruction by parasites and predators of those aphides surviving the fumigation has also been observed on infestations of black-fly, *Aphis fabae* (Scop.) and the potato aphis, *Myzus persicae* (Sulz.), none is more suitable for a quantitative study of the phenomenon than the cabbage aphis, *Brevcoryne brassica* (L.).

The biotope of the Brussels sprout field lends itself particularly well to population studies, because the number of Brussels sprouts plants per acre is small, and under Bedfordshire cropping conditions constant (4,840). The plants are set at intervals and the infestation by cabbage aphis lasts for many months, May–November. The cabbage aphis has a fair number of predators—coccinellids, *Coccinella 7-punctata* (L.), and *Adalia bi-punctata* (L.): the larvæ of syrphids, *Syrphus ribesii* (L.), *S. balteatus* (De G.), and *Catabomba pyrastri* (L.); and the larvæ of cecidomids, *Phaenobremia* sp. (Petherbridge &

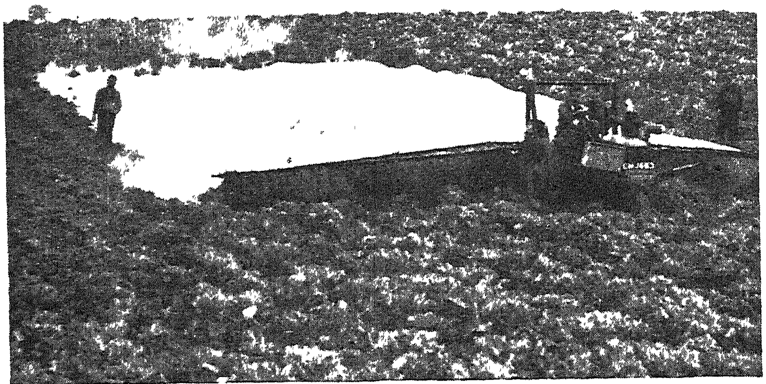


Photo: Farmer and Stock-Breeder.

FIG. 1. FIELD FUMIGATION CARRIED OUT WITH TRACTOR-MOUNTED GASSING MACHINE, VAPOURIZING 95 PER CENT NICOTINE.

Wright[19]); and one important parasite—*Aphidius brassicæ* (Marsch). In a normal year these beneficial insects live with their host in a state of equilibrium for the greater part of the year, resulting in a severe infestation of the plants by the aphides, which cause a good deal of damage. At the beginning of the autumn, parasitism increases and the pest, having spoilt the crop, is often overwhelmed by its natural enemies at the end of the growing season.

This is in agreement with the results of the work of Ullyett[20], who has shown that, despite the higher biotic potential of the parasite, the latter is at a disadvantage compared with the aphis because (1) of super-parasitism, (2) some of the parasitized aphides are able to reproduce before the parasites kill them, and (3) every individual aphid is reproducing.

In order to prevent damage it has become the practice to gas the Brussels sprouts in the middle of August or in September, vapourizing up to 3½ lb. of 95 per cent nicotine per acre. All the cabbage aphides are exposed to toxic fumes for 60 sec. under a gas-proof drag sheet which provides a movable fumigation chamber fitted to a gassing machine moving at a speed of one mile per hour (see Fig. 1).

To study the population changes of aphides and their enemies, a method of measuring the population before and at regular intervals after treatment was developed. As the population of aphides per plant shows great variety in size, plants were sampled at random and grouped in three classes according to the various degrees of infestation. Representative samples were then taken of several plants in the three classes. These plants were then analysed by counting (1) predators, (2) live aphides showing no signs of advanced parasitism, (3) aphides killed by parasites. Figures thus obtained for 'parasitized' aphides refer only to those in advanced stages of parasitism, when the aphides are dead and show a change in colour. This simplified the counting by avoiding dissections and introduced a constant error which does not obscure the phenomenon. For counting, a gravimetric method was used. It was possible for one full-time worker to ascertain the population of a field in two to three full days' work. Population counts were taken by this method before gassing and immediately after treatment, and at intervals later to show the after-effects of the selective insecticide on the aphis population.

As fumigated aphides drop off the plants, the mortality achieved by the direct effect of gassing was ascertained by fixing black cloths under a number of plants before the treatment and counting the live and dead insects remaining on the plants and those collected on the cloths. 'Parasitized' aphides were then transferred to test tubes and the parasites reared.

The results obtained from this survey by the above method follow a general pattern, which will be described, using as an example data relating to the field of Messrs. Bates Bros., of Roxton, Beds (see Fig. 2).

The infestation on the Brussels sprouts in the field to be treated (B) and equally in the adjacent control (A) was severe, 98,000,000 and 22,000,000 aphides per acre respectively. On both fields the parasitism, as expressed as percentage of dead aphides parasitized by *Aphidius brassicæ*, was low, 3·0 per cent and 3·1 per cent. The number of aphides per one syrphid larva was 101 and 103. There was no infestation by *Entomophtora aphidis* and there were no predators except syrphid larvæ. The weather was dry and hot.

The field B was fumigated by two commercial tractor-mounted gassing machines of Pest Control Ltd., Model 1942, on July 28 between 1 and 5 p.m.: the temperature was 78° F. and the drop-off of the dead aphides instantaneous. The first counts were taken on July 31, showing a kill of aphides of 99·9 per cent.

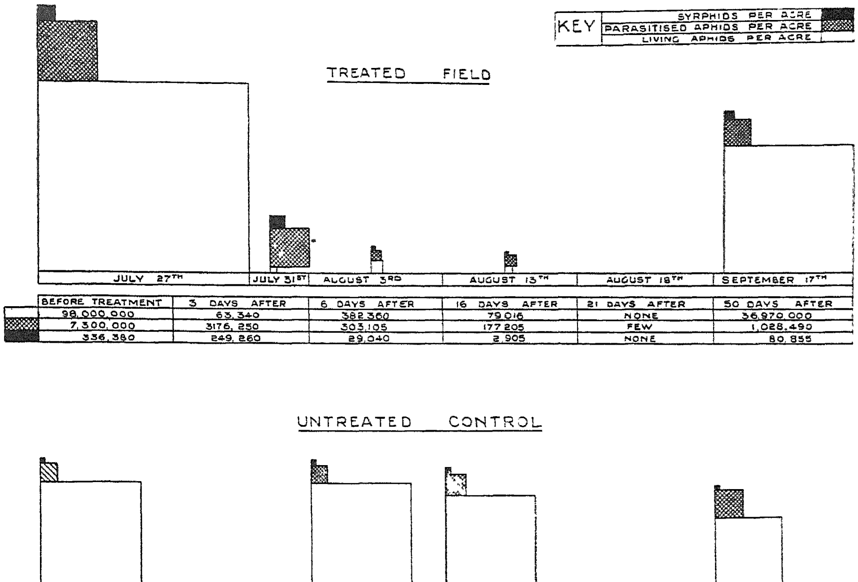
Gassed 'parasitized' aphides were collected and the parasites reared in comparison with 'parasitized' aphides, from untreated fields. 100 per cent emergence was recorded in both cases.

On the treated fields the aphis population on July 31, three days after gassing, was found to be only one-thousandth part of the population before gassing. After a further three days a fourfold increase in the number of living aphides was counted, but this was again reduced to less than a quarter sixteen days after treatment. The infestation was then still of the order of a thousandth part of the initial population, and three weeks after gassing no living aphid could be found on the field. All aphides which survived the gassing had been killed by parasites or predators irrespective of whether they were mutants more resistant to nicotine, aphides which escaped merely because they were in a particularly protected position, or chance arrivals migrating to the field after the treatment. On August 18, three weeks after the treatment, on the whole field no living and only a few parasitized aphides could be found.

With a non-selective insecticide, we should expect the pest population to build up again immediately after the treatment during the summer months, particularly in cases such as the cabbage aphis, which migrates continually. This migration, incidentally, is probably responsible for the increase of the aphides between the third and sixth days after gassing.

The treated field remained free from aphides until the end of the fourth week after the treatment, and only then the infestation built up until, fifty days after treatment, the population reached again a serious infestation.

It is obvious that practical control would be carried out in such a way as to prevent re-infestation. Therefore, either the treatment would be deferred to such a date as would ensure that the period during which the parasites keep the newly arriving migrants in check extends over the migrating period, or the treatment would be repeated when the protecting effect had reached its end.



JULY 27TH	JULY 31ST	AUGUST 3RD	AUGUST 13TH	AUGUST 18TH	SEPTEMBER 17TH
BEFORE TREATMENT	3 DAYS AFTER	6 DAYS AFTER	16 DAYS AFTER	21 DAYS AFTER	50 DAYS AFTER
98,000,000	63,340	382,360	79,016	NONE	36,970,000
7,300,000	3176,250	303,105	177,205	FEW	1,028,490
336,380	249,260	29,040	2,905	NONE	80,855

JUL. 27TH		AUGUST 3RD	AUGUST 13TH		SEPTEMBER 17TH
22,000,000		21,000,000	18 698,000		10 081 000
632,000		640,000	1,000,600		2,006,000
41,000		40,200	86,870		26,820

FIG 2. EFFECT OF CHEMICAL AND BIOLOGICAL CONTROL ON THE POPULATION DENSITY OF CABBAGE APHIS AND ITS PRINCIPAL ENEMIES, THROUGH TREATMENT WITH A SELECTIVE INSECTICIDE.

If we compare the densities of the aphis populations on the treated and untreated field, we see that the population on the untreated field remained almost stationary through the summer and decreased towards mid-September to about half its magnitude on July 28, the date when the first field was gassed.

If we look at the number of parasitized aphides per acre we observe a great change in the proportion of parasitized aphides to living aphides, before and after treatment. While the number of aphides is reduced to one thousandth of its original figure, the number of parasitized aphides is only reduced by a half. Thus the superiority in the number of parasitized aphides over living aphides became paramount until, after three weeks, the parasites had completely wiped out the living aphides. At that time, as mentioned before, *no* living aphid could be found—merely a few dead parasitized ones.

Adult parasites feed normally on the honey dew excreted by aphides, and as the aphides had disappeared and no substitute food had been provided, the Aphidius adults emerging from the parasitized aphides three weeks after treatment were left to starve, the newly arriving cabbage aphis migrants being unable to support them. Thus most of the parasites died of starvation and a new big infestation was therefore built up.

It is worth noting that the parasites which, after treatment, outnumbered the cabbage aphis, remained in this overwhelming majority until the aphides were wiped out, while the hover fly larvæ which, three days after treatment, were only slightly fewer than before treatment, had almost disappeared so early as six days after treatment. Most Syrphid larvæ pupated, and female hover flies were not sufficiently induced by the small number of aphides left after treatment to lay their eggs, so that the population of hover fly larvæ decreased rapidly. Hover fly larvæ disappeared completely three weeks after treatment, showing that they can be relied upon to help in the cleaning-up of the pests *immediately* after treatment by vapourized nicotine. But as their superiority in number soon disappears, the population of hover fly larvæ, though a powerful factor, is a short-lived one in the biological control of the pest following the application of a selective insecticide.

In the untreated field the populations of parasites and hover fly larvæ remained fairly constant for four weeks after the date of treatment of the gassed field, but towards mid-September the percentage of parasitized aphides had significantly increased in accordance with the usual trend.

That the results described are typical was shown by the close agreement of further data obtained by quantitative analyses of aphis population counts after gassing on other fields. The mortality varied with the temperature at the time of treatment, but even when it was so low as 87 per cent, the after-effects of the treatment followed the same general pattern, provided that there was an initial parasitism and an initial population of predators before the field was treated.

Treatment with a selective insecticide should not be carried out at too early a stage of the infestation before the beneficial insects are established.

Summing up, it has been shown that chemical control is greatly limited by the development of resistant races of pests through artificial selection caused by the insecticide, and it is proposed to overcome this limitation by a combination of chemical and biological control through use of selective insecticides.

To demonstrate the latter effect field fumigation of aphis infestations by nicotine vapours in short exposures was used. At a dosage of 3¼ lb. nicotine (95 per cent pure) per acre, and an exposure of one minute, a mortality of the cabbage aphides at the rate of 85–99·9 per cent was obtained at temperatures above 60° F., while Coccinellids, their larvæ and pupæ, and the larvæ and pupæ of Syrphids and of the Braconid parasite Aphidius, showed no mortality. Cabbage aphides surviving the nicotine treatment, whether more resistant to nicotine or not, were all

killed by predators and parasites immediately, or by parasites within a period of three weeks, after the fumigation.

As no resistant mutants thus survived the treatment by the selective insecticide and the following attack by the beneficial insects, any possibility of a segregation of a more resistant race was precluded. The search for further selective insecticides would therefore seem to be a promising approach to the extension of the usefulness of chemical control. More rapid progress could be achieved if the comparative physiology of the economically important insect groups were systematically explored.

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SOLAR PHENOMENA AND GEOMAGNETISM

A DISCUSSION on "Solar Phenomena and Some Allied Geophysical Effects" was held at a meeting of the Royal Astronomical Society on March 10. The president of the Society, Prof. E. A. Milne, was in the chair, and the discussion was based upon four papers contributed during the recess by the following authors: Mr. H. W. Newton, of the Royal Observatory, Greenwich ("Solar Flares and Magnetic Storms": second paper); Dr. C. W. Allen, of the Solar Observatory, Canberra ("Relation between Magnetic Storms and Solar Activity"); Mr. M. A. Ellison ("Sunspot Prominences: some Comparisons between Limb and Disk Appearances"); and Dr. H. A. Brück, of the Solar Physics Observatory, Cambridge ("On the Distribution of Intensity within the Solar Corona"). Others who spoke during the discussion were Prof. H. H. Plaskett, Prof. W. H. McCrea, Dr. T. G. Cowling and Dr. A. Hunter.

Solar Activity and Magnetic Storms

Opening the discussion, Mr. Newton referred briefly to the findings of his earlier paper, entitled "Solar Flares and Magnetic Storms", recently published by the Society. A solar flare may be described as a small area of the sun's surface which shows the hydrogen line (Hα) in strong emission instead of absorption; many other lines show reversals. but observations are normally made by Hα light with the spectrohelioscope—Hale's instrument, which has contributed more than any other to our knowledge of these phenomena during the last solar cycle. The term 'chromospheric eruption' has been in use hitherto to describe these sudden appearances of bright emission in the sunspot areas, but the term 'flare' seems, in the light of our present knowledge, to be preferable, since the bright emission itself shows no appreciable movement either laterally across the disk or in a vertical direction.

Flares have been observed since 1934 by international co-operation, under the auspices of the International Astronomical Union, and have been classified, chiefly on the basis of area, on a qualitative scale of 1, 2, 3, the last being the largest and most intense. Mr. Newton now selects from these records and from an earlier list by Hale, a total of thirty-seven flares which, by reason of great extent (area comparable with the largest spot-groups), duration or intensity, are judged to be of outstanding importance, and these are designated 3 +.

The collection of data relating to these specially intense flares and their subsequent discussion lead to results which are of the greatest interest to geophysicists. In the first place, it is very significant that, of the thirty-seven flares listed in Newton's table, magnetic storms began within 2·0 days of the flares in no fewer than twenty-seven cases, and two thirds of the associated storms are 'great' storms, having a range at Greenwich in $D \geqslant 1°$, or in H or $V \geqslant 300\,\gamma$. Since, even at solar maximum, great storms are rare events (about 3·2 per year), the total number of chance coincidences of a flare day occurring within 2·0 days of the commencement day of a great storm can be shown to be just *one* for the twenty-eight flares in the central zone of the disk. Actually seventeen such coincidences were discovered. The time interval (storm begins *minus* flare first observed) given by the data is $25{\cdot}7 \pm 1{\cdot}5^h$; but the largest five of the great storms give $20{\cdot}3 \pm 0{\cdot}9^h$, and this difference is considered to be real in view of the probable errors.

The distribution of intense flares over the sun's disk prior to great magnetic storms was next considered, each flare being regarded as a source-point for corpuscular emission. Dividing the flares into 'central zone' (0°–45°) and 'outer zone' (45°–90°) flares, and analysing the data by the 'superposed epoch method', there emerges a much closer association between the central zone flares and magnetic storms than is the case for those in the outer zone. Furthermore, since the magnetic records are necessarily more complete than the solar flare records, it is possible to extend the available data by working back from the records of great storms and postulating intense flares on the sun's disk about one day earlier to account for them: these flares would most probably be located near the largest or most active spot-group present on the disk at the time. Maunder and others have, of course, shown that there is a statistical relationship between the central zone passage of great spot-groups and the greatest magnetic storms. These 'deduced' flares, like the observed flares associated with great storms, are found to favour the central regions of the disk.

The whole body of evidence is consistent with the following general hypothesis: (1) an intense solar flare emits ultra-violet radiation, reaching the ionosphere at the same moment as the Hα emission seen with the spectrohelioscope, and gives rise to the synchronous wireless fade-out and magnetic 'crotchet'; (2) there is a newly formed, cone-shaped corpuscular stream ejected at the time and place of the flare, having a semi-vertical angle as large as 40°, or

occasionally larger; (3) the arrival of this corpuscular stream about twenty-six hours later, reaching the earth in a 'head-on' encounter, is the cause of the great magnetic storm with its incidental auroral effects.

The general results of Newton's second paper show that the close relationship between flare and geomagnetic storm is much less definite when the next intensity class (3) of flare is considered. For flares of medium intensity (2) there appears no appreciable connexion between the dual phenomena. Although it seems that a further step has been made in tracing the solar origin of the more intense magnetic storms, Newton has himself emphasized the fact that the smaller magnetic storms which occur during the minimum of the 11-year solar cycle still remain unrelated generally to visible disk markings. The solar origin of these storms is, however, strongly suggested by their tendency to recur at intervals of a solar synodic rotation, as first shown by Maunder forty years ago.

In Dr. Allen's absence, his paper was summarized by Dr. H. A. Brück. Allen's work provides independent confirmation of Newton's conclusions and the well-established association between great magnetic storms and solar flares. Its main importance appears, however, to lie in the attempt to study the cause of those smaller magnetic storms and disturbances the solar origin of which is betrayed by their 27-day recurrence tendency, but which do not show any correlation with observable solar phenomena. Grouping magnetic disturbances observed over a period of thirty-six years according to their recurrence tendency, Allen seeks correlations between the occurrence of the different types of disturbance and the observation of large sunspot groups. For a shorter period of about four years he has also investigated possible correlations between magnetic disturbances grouped according to their recurrence tendency, intensity and sudden commencement and the observation of solar flares or radio fade-outs produced by such flares.

The results of his investigation lead Allen to the conclusion that the influence of the *M*-regions on the sun (in which the origin of the minor magnetic disturbances is to be sought) is affected by the presence of sunspots in their neighbourhood. When these are within 40° of the *M*-region, they seem to deflect the emitted particles in very much the same way in which streamers in the solar corona are deflected by regions around sunspots. This, and the particular persistence of the *M*-regions or recurrent disturbances one or two years before sunspot minimum when the equatorial coronal streamers have their greatest extension, suggests according to Allen that *M*-regions are identical with coronal streamers. Their base appears to cover an extended region on the sun from which the corpuscular emission is constrained to move in limited streams by forces in the solar atmosphere. Allen's *M*-regions are therefore rather different from the relatively small *C*-regions of abnormal emission in the coronal line λ 5303 found by Waldmeier (1942) and identified by him with the *M*-regions. Further studies of the recurrent disturbances during the present solar minimum might possibly bring a decision in favour of one or other of the two hypotheses.

Prominence Motions

Describing his paper on sunspot prominences, Mr. Ellison remarked that, hitherto, our knowledge of the forms and motions of prominences had been drawn almost exclusively from the study of *elevation* pictures taken at the sun's limb. The principal instruments in use have been the visual eye-end spectroscope, the spectroheliograph, and, within the last decade, the Lyot coronagraph and the interference polarizing monochromator. The monochromator, as developed by Pettit at Mount Wilson Observatory, following up the original suggestions of Öhman, promises to prove the most generally useful where the study of rapid motions in prominence features is concerned.

With the development of the spectrohelioscope by Hale in 1926, there arose the possibility of studying the motions of sunspot prominences in *plan* view upon the sun's surface by light of the Hα line. It was immediately found that direct readings of the line-of-sight velocity of prominence streamers could be obtained, through the Doppler shifts of the spectral lines, while the horizontal movements were being followed. Thus arose the three-dimensional method of attack. The disk appearances, when these prominences are to be seen by absorption against the brighter background of the chromosphere, also provide fuller and more continuous records, with special reference to the state of activity and stage of development of the parent spot-group. The precise location of the prominence filaments and arches in relation to the spots is likewise of considerable importance in any discussion of the causes of their rapid movements. Observations of this kind made during the past 11-year cycle of solar activity have been contributed mainly by the observatories at Greenwich, Zurich and Sherborne, and Mr. Ellison explained that the present paper was intended to summarize these findings and to provide a correlation with the corresponding types of limb prominence.

Most frequent in occurrence are the inflowing filaments of short life which originate in the surrounding chromosphere or in 'coronal clouds' formed above the spot area, move along curved trajectories and finally terminate near the boundary of the penumbra with a mean velocity of inflow of 48 km./sec. Their mean projected length is 61,000 km. and their movements are found to be independent of the magnetic polarity of the attracting sunspots. These filaments are now regarded as being identical with the 'Fleckenkronen', described by Fényi (1891) from limb observations, and with the "Jets and Rockets" of Evershed's memoir of 1917: they are therefore placed under Type III*a* of the Pettit classification (1943).

Complex formations of loops and arches over sunspots are rare, but single and double arches are frequently seen, with the spectrohelioscope, connecting adjacent sunspots of the same group. The direction of motion of the gases is upwards on one side and downwards on the other side of the arch, only one case in thirty-one having been observed where matter was clearly in descent on both sides of the same arch. Because of their Doppler displacements, such objects cannot be recorded in their entirety with the spectroheliograph. The mean distance between the legs of the arches is 43,000 km., and the mean velocities of inflow and outflow are found to be 39 km./sec. and 28 km./sec. respectively. Such prominences are identified with the arches of Type III*b* in Pettit's limb classification, and the directions of motion are again independent of the magnetic polarities of the associated sunspots.

A further type of great interest is the flanking prominence (Type III*c*), often of great dimensions,

the form, growth and decay of which is intimately connected with the life-history of the adjacent spot-group. These exhibit much internal activity, as well as forming external streamers which leave the tops of the prominences to flow horizontally inwards and downwards into the spot area.

Mr. Ellison emphasized that the slender trajectories, perhaps 100,000 km. in length and no more than 5,000 km. thick, have not received any satisfactory explanation or likely parallel in terrestrial physics. They give one the remarkable impression of being semi-permanent conducting paths along which bright condensations follow one another at frequent intervals over a period of several hours. Such motions were first studied in the cinematograph films taken by McMath. In the horizontal trajectories it would seem that gravity must be compensated by radiation pressure, and that the motive force along the trajectory may be of an electrostatic nature. This, however, introduces a difficulty, for the highly conducting properties of the hot solar gases would appear to prevent the collection of electrostatic charges.

Photometry of the Corona

Dealing with his investigation of the intensity distribution within the inner corona, Dr. Brück mentioned that Waldmeier had recently published a paper on the same subject in which he found signs of a connexion between intensity gradients and the structure of the corona. Dr. Brück's photometric work confirms Waldmeier's suggestions in greater detail. It has been based upon a plate which was obtained by the late Prof. H. F. Newall during the eclipse of August 30, 1905, in Algiers, and at the same time as the plate from which Waldmeier's conclusions had been derived.

The distribution of intensity has been determined from records made with a microphotometer along seventy-two solar radii equally spaced in position angle, and the results have been represented by a series of isophotes covering an intensity ratio of mag. 2·5. These are sensibly circular, as is to be expected for an eclipse near sunspot maximum, but show considerable local variations corresponding to the structure of the corona on the original negative. Intensity gradients, when derived for a region extending from a distance of about 2′ to a distance of about 5′ from the solar limb, show systematic variations with position angle in the sense that intensities, and therewith densities of scattering electrons, seem to decrease less rapidly with increasing distance from the sun when measured along rays than in 'normal' regions in between. The opposite effect has been observed by von Klüber for streamers in the outer corona, which extend from about 6′ to about 70′ from the limb.

As a consequence of his own work, Waldmeier believes that the inner corona is composed of a spherical shell of electrons, atoms and ions. The electrons, by scattering light from the photosphere, give rise to the continuous spectrum of the corona. Over the sunspot zones, where the ultra-violet and corpuscular radiations are assumed to be most intense, the atoms are ionized to a very high degree, losing as many as fifteen electrons, and are left in metastable states from which emission of the forbidden coronal lines takes place in accordance with Edlén's remarkable hypothesis. The increased ionization leads in turn to a greater electron density, with the consequent brightening of the continuous spectrum which has been observed in these regions.

KILIMANJARO: AN ACTIVE VOLCANO

By DR. P. E. KENT

IT is nearly a century since Kilimanjaro was discovered, a snow-capped mountain 200 miles south of the equator, and the highest point in Africa. Until recently it was thought to be quite extinct, but expeditions during the last few years have produced evidence of a recrudescence of activity in the broad Kibo crater which forms the more easterly of the twin summits.

Meyer[1], the first explorer to climb the mountain, observed that in 1889 the crater floor was almost entirely covered with weathered ice, commenting "the volcanic activity of Kilimanjaro is now a thing of the past; there is no trace even of fumaroles". He recognized, however, that the local emergence of the rock floor indicated a relic of internal heat.

From the time of the first discovery, however, the amount of ice has been diminishing. In 1889 the crater basin discharged ice through a gap in the western side, but in 1906 discharge had ceased, and there has been no connexion between the crater ice and the glaciers of the mountain slopes since that time. A detailed map by Klute[2] dating from 1912 showed large isolated masses of ice and snow on the crater floor, including a mass practically in the centre, and in 1921 Gillman[3] was able to detail considerable reductions in the ice masses, which he thought might be due to climatic fluctuation. In the next few years further evidence of the reduction was obtained[4], and Mittelholzer[5] published a series of air photographs taken early in 1928 which showed the crater floor mantled with only a thin and patchy covering of snow, and showed a perfectly preserved central crater pit (located where Klute had mapped an "Eisburg") which had apparently not been seen before. Subsequent air photographs show that snow conditions were virtually unchanged in 1932, but that there was a temporary increase in quantity in 1937[6] and that in mid-1942 the greater part of the rock floor was clear[7]. There was thus a rapid decrease in the snow cap in the period preceding 1928, fluctuation during 1928–37, and subsequent further reduction.

H. W. Tilman[8] climbed the mountain in 1930 and 1933. He found the snow on the outer slopes much reduced between the two visits, and in 1933 observed sulphurous fumes and pieces of sulphur in the crater —the first signs of the gas emission which has since greatly increased.

Two years ago, fresh evidence was obtained. J. J. Richard ascended the mountain in the autumn of 1942 and saw several well-developed fumaroles surrounded by sulphur deposits, and found that the rocks were warm in several places[9]. Early in 1943, he climbed the mountain again in company with Mr. Spink of the Meteorological Department of East Africa[10], and found that the number of fumaroles had increased from about six to twenty, and that sulphurous fumes could be detected at some distance. Reports from the western side of the mountain described underground rumbling noises and earth tremors.

Spink[11] has since reported a visit to the crater on July 18, 1943, and a detailed account of the phe-

nomena observed has been published in East Africa[12]. Activity was most strongly developed on the western and southern sides of the crater area, where almost continuous parallel lines of fumaroles were found associated with extensive beds of crystalline sulphur. Emission of sulphurous and acrid-smelling gases was so copious that they could be detected a considerable distance away. The temperature of the fumaroles varied from 52° to 78° F. It was found that parts of the ground were warm and soft, so that the mountaineer frequently sank to his knees: the broken surface gassed freely, and it was clear that the gas emission was by no means confined to the obvious vents.

It is evident from these observations that the fumarole activity is increasing to a considerable volume, and there can be no doubt that the mountain should not be classified as extinct. The central pit in the crater first photographed by Mittelholzer is one of the most perfectly preserved vents in Africa, comparable with the pits in the craters of some of the active Mufumbiro volcanoes in Uganda. It may well have been formed within the last few hundred years, although the presence of a permanent ice cap may have had a protecting effect and the fresh appearance may be somewhat deceptive.

The presence of active volcanoes in East Africa makes one wonder whether there will ever be a recurrence of the great eruptions when enormous areas of the highlands were flooded with lava and covered with layers of volcanic ash. The active volcanoes occur in three widely separated areas: west of Kilimanjaro, the mountain Doinyo Ngai has erupted at intervals during the last fifty years; far to the north in Kenya, Teleki's and Andrew's volcanoes at the southern end of Lake Rudolf have been occasionally active; and in Uganda, Nyamlagira of the active Mufumbiro group discharged a lava flow into Lake Kivu in 1938. In the intervening areas hot springs are known in many places, for example along the shores of Lakes Hannington, Magadi, Natron and Manyara (most commonly on the western shores, for some unexplained reason), and steam jets at Eburru in the Njorowa gorge and in the volcanoes Longonot and Meru show that underground temperatures are still high over a wide area.

It is usually supposed that the localized activity of the volcanoes is a last dying glow, the remnant of the great eruptions which produced the plateau lavas. But there is much geological evidence to show that lavas were produced during two separate periods which were separated by a time of quiescence probably as marked as that of the present day. There may, in fact, be a third upwelling of the lava from below over the highlands of East Africa. If there is, one can be sure that it will develop gradually and—if it happens at all—it is not to be expected until many centuries have passed.

[1] Meyer, H., "Across East African Glaciers" (1891).
[2] Krenkel, E., "Geologie Afrikas", Teil 1, 244 (1925).
[3] *Geog. J.*, **61**, 1 (1923).
[4] Mosterz, H., *Z. Vulkanol.*, **12**, 299 (1929–30).
[5] Mittelholzer, W., "Kilimandjaro Flug" (1930), pl. 104–109.
[6] Light, R. U., "Focus on Africa" (1941).
[7] *Illust. Lond. News*, 80–81 (Jan. 16, 1943).
[8] Tilman, H. W., "Snow on the Equator" (1937), 175.
[9] Sinclair, P. J., *The Times* (Dec. 24, 1942).
[10] Sinclair, P. J., *The Times* (May 5, 1943).
[11] Spink, P. C., *The Times* (Aug. 18, 1943).
[12] *East African Standard* (Oct. 8, 1943).

OBITUARIES

Prof. H. F. Newall, F.R.S.

THERE passed away peacefully at Cambridge on February 22, at the age of eighty-six, an astrophysicist of real distinction, who by his personal work in stellar and solar spectroscopic observations and in the design of spectrographs, by his discoveries and by his fine character had a marked influence on astrophysics at Cambridge, both in establishing it as a university study and in attracting younger workers into the field in which he himself had been so notable a pioneer. The first professor of astrophysics at Cambridge, he was a true natural philosopher, who had survived into an era of specialists from a more gracious and spacious age, in which he could study, unhurried, the whole world of Nature and of art.

Hugh Frank Newall was born at Gateshead-on-Tyne on June 21, 1857, a son of Robert Stirling Newall, F.R.S. His mother was the daughter of Hugh Lee Pattinson, F.R.S. R. S. Newall (born at Dundee in 1812) was the head of a considerable firm engaged in the manufacture of wire ropes, which he had himself invented; this firm made the first Atlantic cable, laid by the *Great Eastern*. Pattinson, likewise, had invented a commercial process—the desilverization of lead. R. S. Newall saw two rough disks of crown and flint glass exhibited at the Exhibition of 1862, acquired them and had them made into a lens of 25-in. aperture, which he caused to be erected at Gateshead as part of an equatorial refracting telescope, of focal length 29 ft. Here it was visited by the great and learned of the day. In March 1889—the year in which he died—he offered the telescope to the University of Cambridge.

His son, Hugh Frank, had been educated at Rugby (1872–76) and Trinity College, Cambridge (1876–80) and had then gone as an assistant master to Wellington College (1881–83). The next three years he spent partly abroad, and while he was at Perugia in 1886 an invitation came from the then Cavendish Professor (J. J. Thomson) to become his assistant and demonstrator at the Cavendish Laboratory. This offer coincided with Newall's natural tastes and inclinations and he occupied the post thus offered from 1886 until 1890.

The University of Cambridge was at first not eager to accept R. S. Newall's offer of the big telescope, partly on grounds of expense, partly because of want of a suitably qualified person to take charge. H. F. Newall's own desires were for a career in pure physics, more particularly in spectroscopy—he was much attracted by the inquiries suggested by J. J. Thomson's discovery of the electrodeless discharge through rarefied gases—but he sacrificed those desires and resigned his post at the Cavendish in order to supervise and indeed operate the Newall telescope. It was more than a sacrifice of personal inclination: he not only became henceforward a worker without stipend, but also he paid for the expense of removal of the Newall telescope from Gateshead to Cambridge out of his own share of the family patrimony. From 1891 onwards he was the Newall Observer, and in 1904 he became assistant director of the Cambridge Observatory under Sir Robert Ball. The first "Report" on the proceedings with the Newall telescope was dated 1892. His first paper in the *Monthly Notices of the Royal Astronomical Society* appeared in 1894, entitled "Notes on some Photographs taken with a Visual Telescope". Papers on astrophysics

followed in a regular stream. He never, however, relinquished his original interest in spectroscopy for spectroscopy's sake, and he had the honour of a paper in the first volume (1895) of the *Astrophysical Journal*, on the spectrum of argon, then newly discovered by Ramsey and Rayleigh.

Newall's first thoughts, on being put in charge of the Newall telescope, were to adapt it for photographing and measuring the spectra of the stars. He began by constructing a one-prism spectrograph (the Bruce Spectrograph) for attachment to the eye-end. This, it is interesting to recall, was named after an American benefactor who gave funds for such instruments. It was in action in 1895. Newall also added a correcting lens to the 25-in., to obtain an improved colour curve in the photographic region. The description of the Bruce Spectrograph was published in the *Monthly Notices* of 1896, and reprinted in the *Astrophysical Journal* (Vol. 3) for the same year. With this, and more especially a later four-prism spectrograph which he also designed and put into use in 1899 (though he did not formally describe it until 1905), Newall began systematic observations on the radial velocities of the stars, through the Doppler effects in their spectra. For the accurate determination of wave-lengths in stellar spectra, an iron arc comparison spectrum was used. To astrophysicists of the present generation, this may seem a routine matter. But anyone who reads W. W. Campbell's "Stellar Motions" will appreciate the difficulties that dogged the footsteps of the early measurers of stellar wave-lengths, when striving for an accuracy sufficient to give an error of only a few km. per sec. in the line of sight velocity. There were difficulties due to flexure of the tubes of telescopes when heavy spectroscopic apparatus was clamped on to them—apparatus for which they had not been designed. There were difficulties due to temperature variations. There were difficulties with the production of a comparison spectrum which had to be formed from the same slit, and to be derived from the same spectroscopic train, as the light from the star. There were difficulties even in viewing the stellar image sufficiently clearly to afford accurate guiding. All these, Newall with his own unaided instrumental good sense and sound principles of optical design, and his consummate skill with his hands, triumphantly overcame. He deserves the greatest possible credit for his pioneer work in this field. Newall showed that high-precision stellar spectroscopy was possible, and possible in Great Britain. Without Newall's devotion to a subject not of his own choosing, without his sacrifice of the career in physics which was opening before him, Great Britain would have lagged behind the work then being done by Vogel at Potsdam and Campbell at Lick.

The fruits of this work appeared in 1899 when Newall announced (*Mon. Not.*, 60, 2; 1899) his discovery that the star α Aurigæ (Capella) was a spectroscopic binary; the same discovery was made simultaneously and independently by W. W. Campbell at Lick. Newall's substantive paper "On the Binary System of Capella" appeared in 1900 (*Mon. Not.*, 60, 418; 1900).

Meanwhile Newall had been gaining experience as a solar observer. He took part in an expedition (with E. H. Hills) to Pulgaon, India, to observe the total solar eclipse of Jan. 22, 1898; and in an expedition to Algiers for the eclipse of May 28, 1900. There was also the expedition to Sumatra for the eclipse of May 17–18, 1901; and we may mention here the expedition to Guelma (Algeria) for the eclipse of Aug. 30, 1905, at which he obtained a splendid photograph of the solar corona (a slide of which, by an apt coincidence, was thrown on the screen in the course of a discussion at the same meeting of the Royal Astronomical Society as that at which his death was announced; see p. 454 of this issue). His later expeditions, to the Crimea (eclipse of Aug. 20–21, 1914) and to Norway (June 29, 1927), were frustrated by weather.

Newall's work was recognized by his election to the Royal Society in 1902. During 1905–7 solar instruments were purchased out of the Frank McClean Bequest, and added as an annexe to the Newall dome. These included a 16-in. cœlostat and a 14-ft. plane-grating spectrograph of Littrow type, producing a 6-in. solar image. Again, in 1908 the Royal Society offered the Huggins telescopes from Tulse Hill (a 15-in. refractor and an 18-in. reflector on the same mounting) to the University of Cambridge, and these came under Newall's care in 1909. He was president of the Royal Astronomical Society during 1907–9.

This period of Newall's most intense activity was fittingly crowned by his appointment in 1909 as professor of astrophysics at Cambridge (without stipend) and his election as a fellow of Trinity. In 1911, on the retirement of Sir Norman Lockyer from the directorship of the Solar Physics Observatory at South Kensington, it was decided to transfer that observatory to Cambridge; and in April 1913 the move was effected. Henceforward the old Solar Physics Observatory was fused with the Astrophysics Department and the Newall telescope, and, under Newall as director, the combined Solar Physics Observatory left the control of the University Observatory. Newall held the posts of professor of astrophysics and director of the Solar Physics Observatory until 1928, when he retired and was succeeded by Prof. F. J. M. Stratton, who had been formerly one of his assistant directors. It is understood that the chair was endowed through the generosity of Newall.

Newall observed the spectrum of Nova Aquilæ in 1918. In 1916 he had identified (with F. E. Baxandall and C. P. Butler) the *G*-band in the solar spectrum with a band due to hydrocarbons. Later he occupied himself with problems of solar rotation and the relations between successive spot-cycles, and he devised a promising method for obtaining differentially the departures of the law of rotation of the sun from that of a rigid body.

Newall was an honorary D.Sc. of Durham, a foreign member of the Spectroscopisti Italiani, and a collaborator on the editorial board of the *Astrophysical Journal*. In 1925, he was a vice-president of the International Astronomical Union for its Cambridge meeting.

Newall married, first, in 1881, Margaret, daughter of the Rev. A. T. Arnold, a house-master of Rugby. Mrs. Newall was an experienced eclipse-observer, accompanying Newall on all his expeditions. She died in 1930. He married, secondly, in 1931, Dame Bertha Surtees Phillpotts, sometime head of Westfield College and mistress of Girton. She died in 1932.

Newall was something very much more than the sum of his published papers, or the bare record of his activities. All who came in contact with him recognized him as a man for whom science stood for something large and gracious, a mistress to receive court, to be adorned in lovely garments, not to be soiled by grim contacts with grim workaday life, to hold converse with at leisure, to be reverenced with

serenity. As I have already written and must write again, he was a true natural philosopher, of a kind, I think, more common in the last century than this, to whom curiosity about Nature on the broadest scale was the overmastering motive. In the Newalls' home at Madingley Rise, Cambridge, one heard science talked about in a queenly way, as an intrinsic part of the good life, in partnership with art and music. Sooner or later one met at the Newalls' everyone who counted in astrophysics and the allied parts of physics, and a dinner there was a true meeting of minds, where thoughts could be exchanged on a new phenomenon, a new flower, some development in farming, a Stonehenge discovery or a new star. Newall was the friend of Huggins, Michelson and Hale, and in his knowledge of optical design not their inferior. He was the friend, too, of many younger workers in astrophysics, who received from him hospitality, a captivating welcome and much sound sense as to the directions their energies should take. Withal he was a conservative, loth to embrace modern theories, seeing Nature rather as a complicated spectacle of phenomena than as a stamping-ground for principles. He belonged to the disappearing school which thought that insight into the phenomena apparent in the stars could be gained by consideration of simple laboratory experiments.

Newall was the most modest of men, never referring to his own achievements. Although generally unreserved in his conversation, he clung to reticence about deeper things as to the dress of decency. He was generous in praise of others, and generous and self-sacrificing in all matters of personal conduct. How he would have hated the thought of this his obituary being written! His distinguished personal appearance was the index of a true distinction of mind. We shall long mourn one of the fathers of astrophysics in Great Britain. E. A. Milne.

Dr. J. McKeen Cattell

Dr. J. McKeen Cattell, for the past fifty years editor of *Science*, the weekly journal of the American Association for the Advancement of Science, died in January, aged eighty-three, at Lancaster, Pennsylvania. He was long known as the "dean of American science", although his own subject strictly was psychology. In concurrently editing various periodicals his industry was immense; but he won renown no less as teacher, research worker, and compiler of scientific reference books.

Son of the president of Lafayette College, also in Pennsylvania, Cattell after taking his degree there in 1880 went to study in Göttingen, Leipzig, Paris and Geneva, then returned to Leipzig to gain his Ph.D. in 1886. Two years thereafter he was lecturing in Cambridge, during which time he married Miss Josephine Owen, of London. Psychology as a separate study was in those days in its early development in the United States under Prof. William James of Harvard, and when Dr. Cattell received a call from Philadelphia, to fill a similar chair in the University of Pennsylvania, he went home to his career. In 1891 he proceeded to Columbia University, New York, where for twenty-six years he taught both pupils and teachers, engaging at the same time in researches upon measurement of behaviour, individual and group differences, measurement of psychophysical time, intensity and extensity, perception, fatigue, memory, and association of ideas.

Within about ten years after assuming the editorship of *Science*, Cattell began to edit also *The American Naturalist*, devoted to the biological sciences, and compiled the first edition of his "American Men of Science", a "Who's Who" of research workers. (This book, now grown to 28,000 names, unfortunately and surprisingly lacks a subject-index, and the same is true of its companion volume, "Leaders in Education", first published in 1932.)

Cattell was always a man who pertinaciously stuck to causes or views which he believed in, regardless of what might happen to himself therefrom. In October 1917, six months after the United States had entered the War of 1914–18, he wrote to various members of Congress "not to require drafted men to fight in Europe against their will". For this he was dismissed from his professorship at Columbia. Was such dismissal, when the United States was at war, a violation of academic freedom? Eminent colleagues of Cattell's, Prof. John Dewey the philosopher, and Profs. James Harvey Robinson and Charles A. Beard the historians, protested furiously, and Prof. Beard resigned. Cattell later explained that he meant his letter to apply to conscientious objectors only; but he was not reinstated. Having been a member of the staff for a quarter of a century, Cattell then applied for his pension. It was refused him. Whereupon he sued the University for 150,000 dollars. The case was settled out of court by the award to Cattell of 45,000 dollars.

But by this time Cattell was so deeply occupied in editing his various publications that the loss of his post made little difference to him except to give him several additional hours per week to edit still others. Even while the last War was being fought out he began, from an office in the high tower of Grand Central Terminal, New York, to edit *School and Society*, which in the twenty-five years of his direction grew to be perhaps the leading educational journal in America. Longer still—forty years—was his tenure of the editorial chair of *The Scientific Monthly*, and during a critical period he presided also over *Popular Science Monthly*. In these multitudinous activities two of Cattell's four sons ably assisted him, and survive to carry on a considerable proportion of his work.

If, as some have said, there is in the United States no such thing as a school-leaving age, the gospel of unlimited educational opportunity owes much to the preaching of it by Cattell. But, completely enveloped in science as he was, he tended to attribute to it all the blessings of America and none of the difficulties. "The industrial applications of science," he said in one of his prefaces, "have quadrupled the productivity of labour, abolished slavery, the subjection of women, and child labour, and have made possible universal education even to the age of 18 or 20."

In his long career Cattell was chosen president of many learned societies, including the American Association for the Advancement of Science, nor did his stand in the War of 1914–18 deter the French from electing him a Commander of the Legion of Honour. Willard Connely.

We regret to announce the following deaths:

Prof. Karl Schuchhardt, formerly director of the Prehistoric Department of the Folk-Lore Museum in Berlin, aged eighty-four.

Dr. C. H. Townsend, director during 1902–37 of the New York Aquarium, on January 28, aged eighty-four.

NEWS and VIEWS

Committee on Technical Education

MR. BUTLER, President of the Board of Education, has announced in a Parliamentary written answer that the following have been appointed members of a departmental committee to report on higher technological education in England and Wales: Lord Eustace Percy (*chairman*), Dr. D. S. Anderson, Sir Lawrence Bragg, Mr. W. H. S. Chance, Sir Charles Darwin, Dr. E. V. Evans, Mr. B. Mouat Jones, Mr. S. C. Laws, Dr. H. Lowery, Mr. H. S. Magnay, Sir George Nelson, Mr. J. F. Rees, Dr. R. V. Southwell, Mr. H. Fitzherbert Wright, with Mr. Maxwell-Hyslop, Board of Education, as secretary. Officers of the Board of Education will attend meetings of the committee as assessors.

The terms of reference of the Committee are: "Having regard to the requirements of industry, to consider the needs of higher technological education in England and Wales and the respective contributions to be made thereto by universities and technical colleges, and to make recommendations, among other things, as to the means for maintaining appropriate collaboration between universities and technical colleges in this field."

Application of Research in Industry

IN his address "The Application of Research" to the Manchester Chamber of Commerce on March 31, Dr. Andrew McCance said that we should not think of research merely in terms of great laboratories equipped with intricate and expensive apparatus and staffed by scientific wizards aloof from mundane affairs. Valuable information can often be obtained with the simplest equipment, and scientific men are ordinary men whose judgment has been trained to exclude prejudice and to accept only those conclusions which are supported by facts. As example, he referred to investigations on temperature variations in blast furnaces, which have led to a great increase in regularity of output and a corresponding economy in coke consumption. The structure of a research association depends on the organization of the industry. With an industry such as the iron and steel industry, in which the main production comes from a number of large units, each unit can usually make a material contribution to the common cause by undertaking in its own research department a share of the investigations required into a specific problem. Recently, however, this industry has decided to form a new research association, and in future finance for research within the industry in Great Britain will be obtained by a voluntary levy on the ingot production of all producers in the federation. All the work is controlled by a number of committees, dealing with such subjects as blast furnaces, rolling mills, alloy steels, corrosion, etc., and Dr. McCance referred in particular to the work of the Hair Line Crack Committee dealing with the minute cracks which occur in high tensile alloy steel and their prevention, as illustrating the potentialities of co-operative research. This investigation was founded on an effective scheme of co-operation between industrial and university research laboratories.

Research, Dr. McCance emphasized, begins with an attitude of mind, and it is essential first to create the correct attitude of mind in staff and throughout the organization. The research department then becomes an integral part of the production department, planning ahead continually for the creation of new products, new processes and new economics. It is during the initial stage of employing a nucleus of scientifically trained men to create standards for raw materials and products and to investigate faults in manufacture and processes that sympathetic understanding and guidance are most required if antagonism and friction are to be avoided. When the department becomes an accepted part of the organization, additional staff is required to take over the routine work, and the original staff can begin to tackle the more fundamental problems of research-controlled development. Technical control of a business requires the employment of men who have received a technical training. No business can be made more scientific from outside, and Dr. McCance does not believe that a scientific training makes men less practical in their outlook. It is the waste of latent abilities through lack of opportunity or training that should give us more concern, and industry must co-operate in the development and utilization of training facilities if the future supply of competent executives and research workers is to be assured and the enterprise of British industry maintained.

Editorship of *British Birds*

THE place of the late H. F. Witherby, who so successfully conducted *British Birds* through thirty-six volumes, has been taken by Bernard W. Tucker, in accordance, it is understood, with Mr. Witherby's wishes. With Mr. Tucker will be associated in the editing of the journal, Dr. Norman F. Ticehurst and Major A. W. Boyd. *British Birds* has been assiduous in publishing about birds in Britain items of information many of which would otherwise have been lost to record, but it has played a more important part in encouraging scientific observation of bird-life and in suggesting problems and, by example, showing how problems may be tackled. In January 1917, *British Birds* incorporated *The Zoologist*, and thus disappeared after a long and useful history the only magazine which published notes on any aspect of British natural history from any part of Great Britain. The *Scottish Naturalist* performed a similar duty for the northern part of the kingdom, but it is a war casualty. The result is that there is now no magazine available for recording the minor observations of British naturalists on subjects other than birds, so that the cumulative value of the work of that great band of amateur observers, for which Great Britain has long been noted, is being lost. Is it too much to hope that when the War is over a *British Naturalist* will arise, wherein the ordinary student of Nature will be able to put on record field notes of casual interest and articles of connected observations?

Stereoscopic Photographs: 'Polaroid Vectographs'

INFORMATION recently released about the 'Polaroid Vectograph', a system of stereoscopic photography developed by the Polaroid Corporation, reveals that the method is playing an important part in war-time aerial photography. A short account of the underlying principles was given by E. H. Land in 1940 (*J. Opt. Soc. Amer.*, 30, 230; 1940). As in all stereoscopic systems, two photographs of a scene taken from different positions have to be presented to the observer so that the picture taken from the right is seen by the right eye, while that from the left is seen by the left eye. In the 'Vectograph', two very thin polarizing surfaces are located immediately above

an aluminized surface and are oriented so that the vibration directions of the two layers are crossed relative to one another. The light and shade of the 'left' image is controlled by the number of submicroscopic crystals in one of the layers, and that of the 'right' image by the crystal distribution in the other layer. The 'left' image is seen by the left eye through a 'Polaroid' filter placed in front of the eye to act as analyser, the vibration direction of the analyser being crossed with respect to that of the 'left' image. The white areas of the image are thus represented by regions where the polaroid crystals are absent, and the blacks by areas of maximum concentration; further, since the left-eye analyser is parallel relative to the vibration direction of the 'right' image, the presence or absence of crystals in the latter have no effect on the appearance of the 'left' image. A similar viewing arrangement is used to enable the right eye to see the 'right' image.

The result is startlingly effective. The simplicity of the viewing equipment and the approximate superposition of the two images make fusion a matter of no difficulty whatever. When the original photographs are taken from an aircraft, the distance apart at which they are taken can be made large to give the effect of an exaggerated interocular distance. This leads to a greatly enhanced stereoscopic effect which can obviously have very important applications.

Chemical Laboratory Planning

The design of modern industrial chemical laboratories has been dealt with recently by E. D. Mills (*J. Roy. Inst. Brit. Architects*, 51, No. 2, 27; Dec. 1943). The article, although short, contains some useful details and illustrations, with a short bibliography, and should be useful to those responsible for the erection and equipment of chemical laboratories. Further information about such matters as ventilation (which is quite different from that for normal buildings) would have made it more informative and practical. Many architects have very little idea of what is required, and actual figures are not easy to find.

Ancient Astronomy

A series of articles entitled "Man and His Expanding Universe" is appearing in *Sky and Telescope*, the first of which, in the December issue, deals with Egyptian astronomy. As the life of the Egyptians depended on the overflowing of the Nile, the beginning of which occurred near the time of the summer solstice, the priest-astronomers held a very high position because they knew that the solstice took place about the time of the helical risings of certain stars. Owing to the precession of the equinoxes, the same star could not be used indefinitely, and it is possible to correlate the times of the buildings of some of their temples with our modern calendar, by calculating the times of the helical risings of some of the principal stars. The solar temple of Amen-Ra at Karnak was so oriented that at the summer solstice the setting sun was able to shine through the entire length of the temple and illuminate a golden image in the sanctuary, and the worshippers saw, not the image itself, but "the presence of the god Ra himself in the sanctuary".

The subject is continued in an article in the January issue of *Sky and Telescope* which deals with Chinese and Babylonian astronomy, in so far as a knowledge of the subject was applied to the orientation of temples. Reference is also made to Solomon's Temple, which was so oriented that the rays of the rising sun at the spring and autumn equinoxes penetrated to the Holy of Holies and were reflected by the jewels of the high priest. The basilica of St. Peter's, Rome, is placed due east and west, so that the rays of the rising sun at the vernal equinox can illuminate the high altar at the end of the nave. These articles present many interesting features and explain the orientation of public buildings thousands of years ago when astronomical knowledge was often deliberately concealed from the people, thus enhancing the prestige of the priest-astronomers.

Poliomyelitis in Chile

According to a recent official report, only 99 cases of poliomyelitis were observed in Chile during the period 1937–41. 84 of the cases occurred in children less than two years of age, and only one in the age group 5–10 years. No case was observed in persons above ten years of age. Of the 99 cases, 98 showed motor weakness of the lower extremities, and in 11 the paralysis involved the upper extremities also; in one third of the cases the paralysis was bilateral.

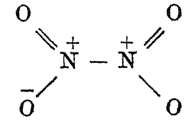
Institute of Physics: Australian Branch

Prof. A. D. Ross, professor of physics in the University of Western Australia, has been elected president of the Australian Branch of the Institute of Physics. The previous presidents have been Prof. T. H. Laby of Melbourne and Prof. Kerr Grant of Adelaide. Dr. Ross has been local honorary secretary of the Institute in Australia for some twenty years, and he was the first to suggest the formation of a branch of the Institute in Australia. The Branch now includes more than 120 fellows and associates, apart from subscribers and students, and active divisions meet regularly during the year in Melbourne, Perth and Sydney.

Pharmaceutical Scholarships for Chinese Students

The Pharmaceutical Society of Great Britain announces that five pharmaceutical manufacturers have each agreed to give scholarships to enable pharmaceutical graduates from China to take a two years course at the University of London. They would then return to China to help to train the 50,000 pharmacists required for General Chiang Kai-shek's ten-year plan for public health services. The donors of the scholarships are Messrs. Allen and Hanburys, Ltd., London; Messrs. Boots Pure Drug Co., Ltd., Nottingham; Messrs. Evans, Sons, Lescher and Webb, Ltd., Speke, Liverpool; The Wellcome Foundation, Ltd., London; and Messrs. May and Baker, Ltd., Dagenham. The suggestion for such scholarships came from Mr. A. H. Bentley, a pharmacist who escaped from the Japanese in Hong Kong. It is expected that the cost of each scholarship will be £1,400.

Erratum. In the communication by H. C. Longuet-Higgins in Nature of April 1, p. 408, formula (iii) should read



The term "nitrogen tetroxide" should have been used throughout, instead of "nitrogen peroxide".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

An Antibiotic from *Aspergillus parasiticus*

RECENTLY we had occasion to examine the possible production of antibacterial materials by about twenty strains of *Aspergillus flavus*, *A. oryzæ*, *A. tamarii* and *A. parasiticus*. The culture fluids showed no significant antibacterial titres when a medium of the Czapek type was used; the test organism was *Staphylococcus aureus* and both the serial dilution method and the plate test[1] were used. When the medium contained bactotryptone or 7–8 per cent of corn-steep liquor together with 4 per cent of glucose and inorganic salts, several of the strains of *A. flavus* and *A. tamarii* produced culture fluids which were weakly antibacterial, being completely inhibitory at dilutions of 1 : 30–80 after 5–14 days incubation at 22–24°. Far superior were the filtrates obtained from four strains of *A. parasiticus*, which gave titres of complete inhibition of 1 : 200–600 after 5–12 days at 24°. A concentrate of the product of one of these four strains was obtained by absorbing the antibacterial principle on charcoal and eluting with aqueous acetone, 50 per cent of the activity being so recovered.

It was later found that in presence of corn-steep liquor additional inorganic salts were unnecessary for the production of antibacterial activity, though copper (1 : 100,000) had a very marked effect on the growth of *A. parasiticus*: with added copper the mould grew luxuriantly with rapid formation of olive-green spores; in its absence, growth was less vigorous and the mycelium remained lemon-yellow for the whole period of growth (up to 14 days). Even added carbohydrate was unnecessary, for the full antibacterial titre developed in 7·5 per cent corn-steep liquor adjusted to pH 7 (the sample of liquor contained a small amount of fermentable carbohydrate). Experiments on the length of incubation using varying amounts of glucose in the culture medium threw some light on the probable reason for the apparent superiority of *A. parasiticus* over *A. flavus*. The former grown in 7·5 per cent corn-steep liquor with 0·5 per cent additional glucose produced maximum antibiotic activity in 4–5 days; the antibacterial titre decreased after 7–8 days though appreciable activity was still present after incubation for one month. With two strains of *A. flavus*, however, activity was markedly more transient, and in one case had disappeared on the ninth day of incubation. The glucose content of the medium had a pronounced effect on the *rate* of production of activity by both species. In cultures of *A. parasiticus*, addition of 2 per cent of glucose (compared with 0·5 per cent of glucose) caused a delay of 48 hours in the production of similar activity, the maximum being reached only on the eleventh day. *A. flavus* cultures showed a similar time-lag, and in addition the maximum activity attained was considerably less in 2 per cent or 5 per cent of glucose than in 0·5 per cent of glucose; indeed, with one strain of *A. flavus* appearance of activity was completely suppressed when 5 per cent of glucose was used.

The products from all the strains of *A. parasiticus* grown with or without additional glucose or salts lost all activity on standing at pH 2 for 30 min. or at pH 11 for 30 min. The active material was extracted by ether, chloroform, or amyl acetate from aqueous solution at pH 2–3, and was recovered in aqueous solution by shaking the extract with a suspension of barium carbonate. The antibiotic was approximately as active against *B. fascians* (a Gram-positive plant pathogen) as against *Staph. aureus*, but was inactive against *B. coli*, *B. pyocyaneus*, *B. prodigeosus* and several other Gram-negative bacterial species.

In both chemical and antibacterial properties the new antibiotic resembles penicillin. Antibiotics of similar character have also been obtained from strains of *A. flavus* in surface[2] and submerged[3] culture and from *A. giganteus*[4], so that the production of such materials is evidently more generally possible than has been supposed. The antibacterial titres obtained from at least one strain of *A. parasiticus* are sufficiently high to make its culture of possible practical value. There is insufficient evidence to decide the identity of penicillin or other Aspergillus products with that from *A. parasiticus*, and it is provisionally proposed to designate the new product 'parasiticin'.

We thank Prof. I. M. Heilbron for his encouragement and the Rockefeller Foundation for financial assistance.

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March 15.

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Trypan Blue and Growth of the Adrenal Cortex in Mice

ACCORDING to a recent communication, Calma and Foster[1] have been unable to demonstrate centripetal cell migration in the adrenal gland of the rat by the use of trypan blue. Salmon and Zwemer[2], using the same vital stain, had previously reported inward cell movement. These last-mentioned workers injected the dye subcutaneously and found it taken up first by the cells in the capsule and after varying intervals by cells of the glomerulosa, fasciculata, and reticulosa successively, while the outer layers became dye-free.

More than two years ago, while I was working on the X-zone of the mouse, adrenal experiments similar to those of Salmon and Zwemer were started but discontinued with the publication of their report. The appearance of Calma and Foster's letter prompted a re-examination of old slides and a study of more mice. In one experiment five animals received ¼ c.c. of 1 per cent trypan blue for two days, and then left and right adrenals were examined separately after intervals of approximately six days; thus each animal served for two observations. The last adrenal was removed sixty days after the termination of injections.

Inspection of histological preparations of these glands supports the findings of Calma and Foster, namely, that this method yields no evidence of inward cell migration in the adrenal gland. Dye was present in the capsule of every gland, and in greatest amount (to judge by granular size) in the region of the glomerulosa and outer fasciculata.

Goldman[3], in 1909, reported blue granules in the majority of the cortico-adrenal cells of animals receiving excessive amounts of trypan blue. This was clearly demonstrated in one animal sacrificed after 28 successive injections of ½ c.c. of 1 per cent dye. Granules were found not only in all areas of the cortex but also in the cells of the medulla. Thus it would appear that the capsule, glomerulosa and outer fasciculata preferentially store the stain, but that when an immoderate quantity is supplied to the organ the other cells are called to aid in the storage process.

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Microbiological Assay of Riboflavin

Experiments in these laboratories using *Lactobacillus helveticus* for riboflavin assay by the method of Snell and Strong[1] have brought to our notice the importance of the temperature of incubation of the cultures.

Position in Incubator	Front						Middle								Back
Tube No.	1	3	5	7	9	11	13	15	17	19	21	23	25	27	29
ml. 0·1 *N* NaOH	3·4	3·55	3·6	3·95	4·05	4·15	4·9	4·45	4·15	3·85	3·75	3·75	3·7	3·65	3·55
Tube No.	30	28	26	24	22	20	18	16	14	12	10	8	6	4	2
ml. 0·1 *N* NaOH	3·5	3·7	4·0	4·0	4·2	4·15	4·55	4·25	4·3	3·85	3·65	3·8	4·05	3·95	3·7

Snell and Strong, and other authors of *L. helveticus* assay methods, advise that the cultures should be incubated at 37° C. We have found, however, that a somewhat higher temperature, in the neighbourhood of 41°–42° C., results in a considerable increase in acid production with a given sub-optimal dose of riboflavin. This is in accordance with Bergey's[2] statement that the optimum temperature for this organism is 40°–42° C. The decreased growth-response resulting from a deviation of 4°–5° C. from this optimum is appreciable and may easily be of the same order of magnitude as that produced by a 25 per cent decrease in riboflavin concentration. (The actual figure depends, of course, on the slope of the dose-response curve in a given experiment, and in cases where this is unusually flat a much higher figure is obtained.)

This observation, which so far as we are aware has not hitherto been reported, is not merely of theoretical interest. Indeed, we have found that the somewhat uneven distribution of temperature in an ordinary bacteriological incubator is sufficient to affect seriously the uniformity of response obtained in a series of identical tubes each containing a sub-optimal dose of riboflavin. The accompanying table shows the titration figures obtained when a series of identical tubes of medium, each containing 0·075 γ riboflavin per 10 ml., was placed in two adjacent rows across the middle of the incubator from front to back; the temperature indicated by the incubator thermometer was 37° C.

It will be seen that the tubes in the middle of each series have, in general, given much higher titration figures than those at the ends. The results are explained by the fact that in this particular incubator the front and back are cooler by some 3°–4° C. than the middle. Similarly, the sides of the incubator are hotter than the middle. The existence of such temperature gradients will not only influence the consistency of replicate tubes, but also the slope of a dose-response curve will obviously be affected by the position of the series in the incubator.

Ideally it is desirable that an incubator for this work should maintain a perfectly even temperature throughout. If this cannot be realized by the use of an internal fan or otherwise, the temperature effect can and should be allowed for in the calculation of the results of assays. Using the latter procedure, the re-calculated results are found to be much more uniform than the uncorrected figures, and the method becomes one of precision. Fiducial limits of 95–106 per cent ($p = 0·95$) have been obtained when five tubes were used at each of five levels of standard and four of unknown. On this basis, 83–120 per cent fiducial limits could be obtained with a total of eight tubes (four standard, four unknown).

The basis of these assay methods is that the vitamin under test should alone be the limiting factor influencing growth. It seems, therefore, that unless *either* stringent precautions are taken to ensure uniformity of incubation temperature, *or* appropriate allowances made for non-uniformity, errors of appreciable magnitude may be introduced. On the other hand, the application of statistical treatment appropriate to the conditions renders the method one of high precision.

Further work is in progress and will be reported more fully in due course. We are indebted to Mr. E. C. Fieller for the statistical analysis of our results.

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Mathematics of Biological Assay

D. J. Finney observes[1], in effect, that the data of a four-point assay in which the apparent response curves are not parallel do not allow us to distinguish between two conceivable causes of non-parallelism, namely, (1) non-linearity of the fundamental response curve, and (2) real dissimilarity between the response curves of standard and test material; and that while the first does not invalidate the assay[2,3], the second does. To this we may add that the smaller the difference between the overall mean responses to standard and test material the more reason there is to attribute non-parallelism to the second cause. The whole matter is particularly relevant to the vitamin A assay, which employs a non-vitamin A standard and in which there are therefore no "strong *a priori* reasons for believing that the standard and test

preparations have response curves of identical form"[1]. In this laboratory, statistical check is kept on the difference between the constants of slope for standard and test material (which is equivalent to a check on the value of T, as defined by Finney). No significant deviation has, in fact, been found, but it cannot be assumed that this would apply to other regimes.

Finney's formula for the exact fiducial limits of M, the log dose-ratio between standard and test material, is algebraically identical with that recently discussed by Irwin[4], and its importance is perhaps not widely enough realized. May I suggest a version that is fairly simple to handle ?

Adopting Finney's notation, we may write the fundamental formula for M as

$$d\,\frac{S \pm t_S\varepsilon_S}{R \pm t_R\varepsilon_R}, \quad . \quad . \quad . \quad . \quad . \quad . \qquad (1)$$

using separate t's and ε's because in practice R and S are often based on different numbers of animals. The limits of error alone may be written, in approximation,

$$\pm\, d\,\frac{S}{R}\sqrt{\left(\frac{t_S\varepsilon_S}{S}\right)^2 + \left(\frac{t_R\varepsilon_R}{R}\right)^2}. \quad . \quad . \quad . \qquad (2)$$

Now if the standard error of the slope is more than 13 per cent (that is, if $\varepsilon_R/R > 0{\cdot}13$) this approximation is insufficient, and each R in (2) must be replaced by $\sqrt{R^2 - t^2_R\varepsilon^2_R}$. The mid-point of the resultant, wider, error range then shifts to

$$d\,\frac{S(R^2 - 2t^2_R\varepsilon^2_R)}{R(R^2 - t^2_R\varepsilon^2_R)},$$

although, of course, dS/R still best expresses M.

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Age of the Saline Series in the Salt Range of the Punjab

OF all the debated questions of Indian geology there has been none so baffling as the age of the Saline Series in the Punjab[1]. The selected references cited will give an idea of the controversy that has raged round the question, still by no means closed. Two main theories are now in the field : (*a*) that in the eastern part of the Salt Range the Cambrian sequence, with the Purple Sandstone at its base, lies 'normally' over the Saline Series, which therefore must be Lower Cambrian or pre-Cambrian[2] ; (*b*) that the Saline Series is of early Tertiary age and that its inferior position is due to an immense overthrust of post-Nummulitic date which has pushed the older beds bodily over it[3].

Fossils found in the Saline Series in recent years have repeatedly suggested that the beds are early Tertiary or even younger. But the value of this evidence has been questioned : either the specimens were found on scrutiny to be indeterminable or serious doubts arose as to their having been found *in situ*. It has been rightly argued that in such a highly soluble and plastic substance as the Salt Marl, extraneous material might easily have penetrated through solution holes or have been enveloped during relatively modern earth movements, of which there is ample evidence[1]. In view of these objections, I collected, during a recent visit to Khewra (October 5, 1943) and to Warchha (October 14), some lumps of rock-salt with intercalated thin laminæ of saline earth or 'kallar' from positions deep within the salt mines, with the view of examining the kallar for possible microfossils. Here the kallar lies closely interlaminated with the salt, in beds which run continuously for long distances and which, although often highly tilted, show no other visible signs of disturbance. If, as Christie[5] has shown, these saline deposits are a product of normal sedimentation from salt lakes or lagoons, and if these lakes were exposed to the air at a period when land vegetation existed in any degree of profusion, we might reasonably expect to find, among the dust that blew on to the water's surface or in the material that was washed in, at least some microscopic specks of organic matter giving a clue to the life of the period. Further, as between the Cambrian and Tertiary, it should be easy to clinch the matter over a single such speck found *in situ*, provided only that it could be referred to a known group of land plants.

In quest of such a clue I examined a dozen specimens, some collected, as stated, by myself from different places in the mines (with the kind permission of Mr. C. Phillips of Khewra and Mr. B. S. Lamba of Warchha), others kindly sent me last December by Mr. Lamba from the Warchha mine. The order of thickness of the kallar bands in the specimens examined is indicated by the following examples : 1·5 mm. (thinnest), 9 mm., 12 mm., 22·5 mm. (thickest). There is no question here of any cracks or solution holes, nor of any foliation imposed by thrusting or shearing forces such as Dr. Murray Stuart (*loc. cit.*) advanced in explaining the laminated appearance of these deposits.

The investigation of this material has given results beyond all expectation : the bands of kallar must be teeming with signs of life, for every single piece has yielded microfossils. These specks readily float up to the surface where they can, as a rule, be picked out at once by stabbing the film of water with a needle dipped in safranin, which rapidly spreads out and stains all organic fragments. The great majority are undeterminable as to genus and species, being mainly shreds of angiosperm wood, but there are also gymnosperm tracheids with large round bordered pits, and at least one good, winged, six-legged insect with compound eyes. These facts suffice to prove that the Salt Marl of the Punjab cannot possibly be Cambrian or pre-Cambrian as suggested, among others, by Dr. Murray Stuart, Sir Cyril Fox, and now also by Mr. E. R. Gee, until recently a strong advocate of the Eocene view. So, after all, it turns out that the position of the Saline Series beneath the Palæozoic sequence can only be explained, as was first pointed out by Koken and Noetling more than forty years ago (long before we knew any fossils from the Marl), by postulating an overthrust fault of great magnitude.

The main facts here briefly recorded were discussed in a recent address at Hyderabad Deccan[6], where also some of the fossils found by Mr. B. S. Trivedi and myself were described in a joint paper[7]. We are now examining further material, including the gypsum associated with the salt, and the 'oil shales' underlying the Marl near Warchha. We would

be grateful to geologists for any samples of saline deposits of disputed age from non-Indian sources, especially for authentic *in situ* material from the Iranian saline beds which Boeckh, Lees and Richardson have regarded as Cambrian, but which may be of the same age as the Kohat and Punjab salt.

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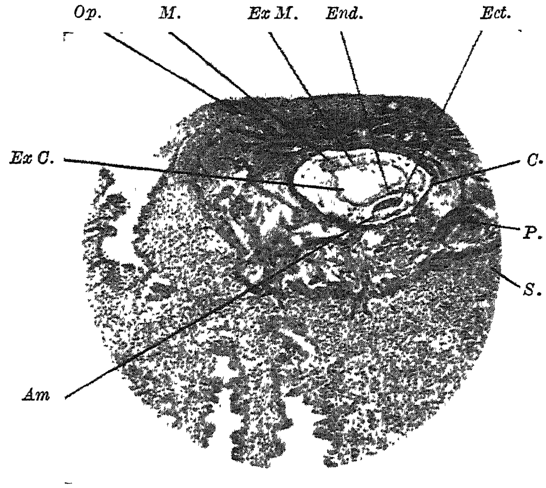
A Human Embryo, Nine to Ten Days Old

A normal previllous human ovum, estimated from both its histological study and the precise menstrual and coital history of the patient to be nine to ten days old, was found in the uterus removed from a young married woman. In its detailed structure it appears to show minor differences from the ovum *Wi*-8004 recently discovered by Rock and Hertig[1] and estimated by them to be 9·5 days old, although the comparison is based solely on a photomicrograph of one section of the latter ovum and the short preliminary report thereon so far published. These two ova represent the earliest specimens of fully implanted human ova yet discovered, and the present specimen shows several features of importance in the early organization of the human embryo.

Heuser and Streeter[2] stressed the precocious formation of the primitive mesoblast in the macaque monkey as compared with other mammals; the present specimen shows that in the human the formation of primitive mesoblast (*M*) is even more precocious. The germ disk has a diameter of 0·117 mm.; that in the 11·5-day Hertig-Rock ovum[3] is 0·138 mm. It consists of a single layer of columnar ectodermal cells (*Ect.*) and a single layer of cubical endodermal cells (*End.*); these two layers have been artificially separated in the process of preparation and no mesoblast penetrates between them. The thin exocoelomic (Heuser's) membrane (*Ex.M.*) is complete, in contrast with that in the 11·5-day Hertig-Rock ovum[3], and, together with the endodermal plate, it encloses the exocoelomic coelom (*Ex.C.*) or primitive yolk-sac. The definitive yolk-sac has not yet developed. The sudden transition of the cubical endodermal cells of the disk to the flattened cells of the exocoelomic membrane favours Heuser's view[4] that, whereas the endoderm is derived from



Section through equatorial region of embryo. (×45)

the formative cell mass, the membrane is formed from the mesoblast. Likewise the change from the columnar ectodermal cells to the flattened cells of the amnion (*Am.*) support the view of Ramsey[5] and Heuser and Streeter[2] that the amnion is mesoblastic in origin. The amnion is not yet complete and deficiencies in its roof are closed in by cytotrophoblast (*C*); here transition cells are found between cytotrophoblast and amnion. The plasmoditrophoblast (*P*) contains lacunæ in various stages of formation; maternal blood is found only in those lacunæ on the abembryonic (superficial) side of the ovum, elsewhere they contain leucocytes.

In the aborted ova described by Bryce and Teacher[6] and von Möllendorff[7], a zone of necrosis of the endometrium was observed surrounding the ova; consequently the belief was held for some time that implantation of the ovum was normally accomplished by necrosis of the maternal tissue. That this is not the case is indicated in the present specimen by the fact that normal stroma (*S*) abuts on the trophoblast. The operculum (*Op.*), indicating the site of entry of the ovum into the endometrium, consists of a mixture of fibrin and leucocytes permeated by plasmoditrophoblast. Ovulation was deduced to have occurred on the ninth day of the menstrual cycle of twenty-eight days; to this early time of ovulation is attributed the fact that the endometrium is as far advanced in the secretory phase on the twentieth day in the present specimen as that on the twenty-fourth or twenty-fifth day in a number of other specimens examined from women in whom ovulation probably occurred nearer the middle of the cycle.

A full account of this specimen is being published elsewhere.

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Feb. 25.

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Nature of Acid in Soft Water in Relation to the Growth of Brown Trout

IN 1937 I made a brief survey of some small lochs in Sutherland, in some of which the water was fairly acid (pH 4·5). I found, as Captain Sawyer[1] has done, that the pH of these waters could be changed very rapidly towards neutrality by shaking with air; and I concluded, like him, that the acidity was due mainly, if not entirely, to dissolved carbon dioxide.

An account of these observations was given to the British Association in 1937[2], and my deductions as to the cause of the acidity were criticized on chemical grounds. Later, further samples from these lochs were collected and were examined by the Government Chemist. He reported (*in literis*) that the water was acid, that the pH was not noticeably altered by aeration and that the acidity was due to a small quantity of a strong acid, of vegetable or peaty origin, in solution. That the pH of these samples could not be changed by aeration made me suspect that conditions in these lochs had changed and, by correspondence, I ascertained that this was so. The samples examined by the Government Chemist were taken after a period of heavy rain and were brown in colour, whereas mine were taken after some weeks of drought and were virtually colourless. It was hoped to continue these observations, but a change of programme and then the War have so far made it impracticable.

The conclusion is that Captain Sawyer has produced supporting evidence for the view that the acidity of the waters of these lochs may at times be due to carbon dioxide, but that the presence and importance of 'humic' acids can by no means be ignored.

Whether these factors have any direct bearing on the varying sizes attained by trout in different waters is open to considerable doubt. When Southern[3] produced the hypothesis that the growth of trout was directly related to the composition of the water in which they were living, he started a hare which many of us have followed for varying distances. I now believe that the solution of the problem is to be sought in the relation between the trout population and the food supply. That this line of attack has formerly been found to be unpromising[4,5] is due to over-emphasis of the latter factor and neglect of the former. It happens that, in soft or acid waters, spawning conditions for trout are often ideal, for the rocks are hard and the redds are consequently free from silt. Hence the percentage hatch is large[6] and the survival-rate continues to be high because the predatory fishes such as pike, perch and chub are absent from such waters. The pressure on the available food is accordingly great, and trout, with their extraordinary lability, respond to the conditions by a general decrease in growth.

In waters where the survival-rate is low, owing either to poor spawning ground or to the presence of predators, the trout grow big, whether the water is acid or alkaline[3].

It is hoped, when time permits, to develop this thesis in a paper in *Biological Reviews*.

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[1] Sawyer, R. E., NATURE, **153**, 55 (1944).
[2] Pentelow, F. T. K., *Rep. Brit. Assoc. Adv. Sci.*, 364 (1937).
[3] Southern, R., *Salm. Trout Mag. Lond.*, Nos. 67, 68, 69 (1932).
[4] Southern, R., *Proc. Roy. Irish Acad.*, **42**, 87 (1934–35).
[5] Frost, W. E., *Proc. Roy. Irish Acad.*, **45**, 139 (1938–40).
[6] Hobbs, D. F., *New Zealand, Marine Dept., Fish. Bull.*, 6 (1937).

Achilles and the Tortoise

PROF. F. G. DONNAN has submitted[1] a very interesting application of the exponential function. I think, however, that his first equation is not altogether accurate. I suggest that the following is rather more realistic.

If y and x are the distances of Achilles and the tortoise from a fixed datum, then

$$\frac{dy}{dt} = 10pe^{-\lambda t};$$

when $t = 0$, $y = 0$ and the constant of integration will be $10p/\lambda$ and

$$y = \frac{10p}{\lambda}(1 - e^{-\lambda t}).$$

$$\frac{dx}{dt} = pe^{-\lambda t};$$

when $t = 0$, $y = d$, their distance apart at the start.

So that the constant of integration is $\frac{p}{\lambda} + d$, and

$$x = d + \frac{p}{\lambda}(1 - e^{-\lambda t}).$$

If D is their distance apart after time t,

$$D = x - y = d - \frac{9p}{\lambda}(1 - e^{-\lambda t});$$

when $t = \infty$, $D = d - \frac{9p}{\lambda}$.

So D may be positive, negative or zero, which rather disproves Zeno's paradox.

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[1] NATURE, 153, 142 (1944).

THE statement of Group-Captain G. S. Roberts, that the first equation in my letter to NATURE to which he refers "is not altogether accurate", would appear to mean that it does not cover the general case of a tortoise with any possible start. It was made clear in my letter, however, that this equation applies only to the case of a tortoise with a *specified* start, namely, 10 units of distance. In this particular case I showed how it was possible, by a special adjustment of the ratio p/λ, to secure the result that Achilles would overtake this *particular* tortoise only in an infinite time. Given this particular (adjusted) value of p/λ, it follows that, for tortoises travelling according to the same law of speed, those with a start of less than 10 will be overtaken in a finite time, whereas those with a start of greater than 10 would not be overtaken by Achilles even in an infinite time.

It is, of course, a very simple matter to give a general algebraic statement valid for tortoises with all possible starts, but I did not consider that the interest of the problem warranted any further elaboration. It was, however, amusing to note that by a suitable adjustment of p/λ one could always make a 'cut' in the infinite set (of tortoises). This point has been well taken in an interesting letter which I have received from Mr. W. J. Chater of Northampton.

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RESEARCH ITEMS

Promin Treatment of Leprosy

IN a recent paper (*Public Health Rep.*, 58, 1729; 1943) G. H. Paget, R. C. Pogge, F. A. Johansen, J. F. Dinan, B. M. Prejean and C. G. Eccles of the United States Marine Hospital (National Leprosarium), Carville, La., record their observations on the treatment of leprosy by promin, the sodium salt of *p.p.*diamino-diphenyl-sulphone-*n.n.*didœstrose sulphonate in a paper based on the study of forty-six cases. Their conclusions are as follow. (1) Promin is the sulphonamide drug which so far seems to possess to the greatest extent some chemotherapeutic properties against leprosy. (2) While no direct evidence of a specific bacteriostatic or bactericidal action against *M. lepræ* has been demonstrated, it has been observed that promin seems capable of inhibiting the progress of leprosy in a considerable number of cases. (3) Promin can be safely administered intravenously for prolonged periods provided the blood and urine are examined frequently. Toxic manifestations, of which hæmolysis is the most important, are relatively few and mild. (4) Further experimental and clinical studies on the treatment of leprosy with promin are required before more definite conclusions can be drawn.

Blennioid Fishes

EARL D. REID has published a review of the genera of blennioid fishes related to Ophioblennius (*J. Washington Acad. Sci.*, 33, No. 12; Dec. 1943). The work is based on examination of material in the collections of the United States National Museum from the tropical Atlantic and Pacific Oceans. The author recognizes five genera of these fishes, two of which, Leoblennius and Bleniella, are new. Keys are given to the genera and to the ten species referred to Ophioblennius, which is widely distributed in the tropical Atlantic, along the west coast of Africa and from the West Indies to Trinidad. In the Pacific it occurs from the coast of southern California to the Galapagos, Chile to the Marquesas, and the Hawaiian Islands. No species, so far, has been found away from the island or group of islands from which the type was recorded. Most of the species collected have been attracted to an electric light and captured in a dip net used from the ship's side while at anchor.

A Canadian Dinosaur

IN 1924 Dr. Gilmore described as *Troödon validus* a remarkable Canadian Cretaceous Dinosaur which combined a small but greatly thickened skull with a lightly built bipedal body. In 1939 the American Museum of Natural History secured a similar but much larger skull from a higher horizon in Montana. This animal has now been described by Barnum Brown and E. M. Schlackjer (*Bull. Amer. Mus. Nat. Hist.*, 82, Art. 5) as *Pachycephalosaurus grangeri*. This remarkable skull is two feet long—three times the size of Troödon—and the dome-like mass of bone over its cranial cavity is from six to nine inches in thickness, while the ventral parts, the palate, etc., are relatively slender. The greatly thickened parietal and frontal bones are known to be composed of finely cancellar bone with dense laminæ running out to the surface in Troödon, and are no doubt of similar structure in the new form. No suggestion has yet been made to account for this development. It can scarcely be protective, because the lightly built slender neck, body and limbs present so much larger a field for attack. A very similar thickening of the cranial roof is found in the Permian Tapinocephalid Deinocephalia, which are very far removed from the Dinosaurs. Indeed, the skull of Pachycephalosaurus mimics in a remarkable way that of these animals; it is of about the same size, has similar general proportions, and has very small teeth much like those of Mormosaurus; and in Tapinocephalids the parietal may be at least 6 in. thick. But the bodies of the members of the two groups are grotesquely unlike; the Deinocephalian body was a great barrel-like structure supported by four short, immensely massive legs, in contrast to the slender body and limbs of Troödon, and its habit of walking on the hind feet alone. It is, in fact, evident that the great thickening of the skull roof of Troödonts has no direct adaptive significance; it, and also that of Tapinocephalids, must be secondary effects resulting presumably from some endocrine unbalance persisting through many thousands of generations.

Hessian Fly Resistance in Wheat

W. B. NOBLE (*J. Agric. Res.*, 67, 27; 1943) shows that Dawson wheat contains two non-allelomorphic factors for resistance to Hessian fly. The progeny of Dawson × Poso and × Big Club, which are susceptible, have been examined. It was found that the two factors separately confer less resistance to Hessian fly attack than in a combined condition. By scientific breeding using this knowledge, recombinants containing both resistant factors have been produced.

Eye Responses of Drosophila Mutants

H. KALMUS (*J. Genetics*, 45, 206; 1943) has studied the optomotor response of different mutants in Drosophila and shows that wild type females with more ommatidia than males follow striped patterns better, whereas a reduction of ommatidia in the Bar series causes a reduction in the degree of response. Eyeless strains of *D. pseudo-obscura*, with about twelve facets, show no response. Homozygous vestigial winged flies react best of all stocks tested, while yellow, black and ebony mutants were similar to wild type. White-eyed flies, W/w, do not react to the striped pattern while homozygous brown-cinnabar flies and apricot flies and homozygous brown-vermilion flies react less than the wild type.

Ionization and Chromosome Breakage

D. G. Catchside and D. E. Lea (*J. Genetics*, 45, 186; 1943) have continued their work on the effect of X- and other rays upon chromosome breakage. They had previously shown that breakage resulted from a minimum of seventeen ionizations per break. They now compare the effect of ionizations from X-rays of different wave-length. The coefficients of chromatid breakage are highest with $\lambda = 4 \cdot 1$ A. and fall off through $\lambda = 1 \cdot 5$ A. to medium X-rays $\lambda = 0 \cdot 15$ A. to Al*K* radiation $\lambda = 8 \cdot 3$ A., where they are least. This is interpreted to mean that only the densely ionizing tails of the electron track are effective in chromosome breakage and that the tails have a higher efficiency only where they traverse the chromatid. When the radiation is performed respectively on pollen grain divisions and pollen tube divisions of Tradescantia, there is a difference in the coefficient of aberrations. The authors show that there is equal probability of survival of chromatid breaks in both

divisions, but interchange in the pollen tube is reduced by the cylindrical shape as compared with the spherical pollen grain nucleus.

New Plant Diseases

Lilian E. Hawker and B. Singh have described a disease of seedling lilies (*Trans. Brit. Mycol. Soc.*, 26, Pts. 3 and 4; Dec. 1943). This was caused by the fungus *Fusarium bulbigenum*, which has hitherto been reported as a pathogen of mature bulbs. The fungus can enter unwounded roots of seedlings and of *Lilium regale*, but cannot enter unwounded bulb scales. Infection from pure cultures of the pathogen produced the typical damping-off symptoms. Application of formalin dust to the seed boxes before sowing gave good control. C. J. Hickman and D. Ashworth record, in the same journal, the occurrence of Botrytis spp. on onion leaves. Three species of Botrytis are apparently involved. *B. squamosa*, recorded for the first time in Great Britain, was the predominant organism, and the others were the ubiquitous *B. cinerea* and another form as yet unidentified. Infection was limited to autumn and winter, and plants usually grew away healthy in spring and summer.

Archæan Rocks of South Harris

FOLLOWING up the pioneer work of Craig and Jehu on the geology of the Outer Hebrides, a detailed study of the Archæan gneisses of the Rodil district of South Harris has been made by C. F. Davidson (*Trans. Roy. Soc. Edin.*, **61**, 71; 1943). The oldest rocks are paragneisses representing a series of shallow-water sediments which included impure dolomitic types. These sediments were intruded by a complex of anorthosite and banded gabbro and norite accompanied by small ultrabasic intrusions. High-grade regional metamorphism followed, leading in general to the formation of eclogite and garnetiferous granulites or charnockites, together with calc-silicate rocks and garnet-kyanite-gneisses. Next came a phase of migmatitization due to the passage of a wave of volatiles through the rocks, whereby plagioclase was locally transformed to scapolite, pyroxene to hornblende and garnet to kelyphite. The final phase consisted of the formation of thick sheets and dykes of acid pegmatite. At a much later stage, possibly Caledonian, representatives of all these rocks were involved in a zone of intense shearing and dislocation, mainly along the east coast of the area. Within the shear zone ultracataclastic structures were developed, and on most of the gneisses close to the shear zone there was imprinted the epidote-saussurite facies characteristic of low-temperature alteration. The paper contains several new chemical analyses and is notable for a valuable discussion of the nature and mode of origin of eclogites and charnockites.

Scattering of Light by Small Particles

EXPERIMENTS to elucidate scattering in the sky and in optical instruments have been carried out by H. Zanstra, who has discussed his investigations on the scattering of light by small rock-salt crystals suspended in a saturated solution (*Mon. Not. Roy. Astro. Soc.*, **103**, 5; 1943). Faber produced artificial haloes in the laboratory by using suspensions of small crystals of various salts in their saturated solutions contained in a cell with parallel walls. Zanstra used Faber's method for producing scattering of a central image by small crystals of rock salt, and measured the intensity I of scattered light as a function of the distance r from the centre. A description of the experimental arrangement is given, and this is essentially that of Faber, except for the fact that monochromatic light is not used. For deflexions less than 20′, diffraction may account for the scattering in the given suspension, but for larger deflexions, between 20′ and 5°, the observations cannot be represented by the theoretical formula. In this case an empirical law connects the intensity with the distance r, the intensity varying as $1/r^{\alpha}$, with α equal to 2·28. This law is of the same type as that for long-range scattering about a stellar image, which was observed by Redman; the value of α in this case was 1·70. The main conclusions obtained suggest that the long-range scattering observed in celestial photographs arises from small ice crystals in the sky, such as are responsible for haloes, and it is believed that any kind of small particles in the atmosphere might produce a similar effect. Observations without rock salt show, however, that another part of the long-range scattering in astronomical observations may be due to the instrument, presumably by scattering of light by scratches, dust particles or edges of diaphragms.

Applied Electron Microscopy

IN a paper dealing with electron microscopy, J. H. L. Watson (*Canad. J. Research*, 21, 89; 1943) points out its advantage when a large depth of focus is desirable. A typical value is 10 μ as compared with 0·4–0·2 μ with optical microscopes. Many electron micrographs are reproduced, covering smokes, mine dusts, paper coatings, and botanical objects (including cutin, which is shown to assume a fibrous nature on older plants). It is suggested that the electron microscope may find application in the study of chromosomes, although it is emphasized that the use of the instrument in botany involves considerable time, experimentation, and skill in suitable preparation. Most of the magnifications shown are of the order of 1,000–1,500, but some (mine dusts) are of 16,100. No details of the electron microscope are given, but a special object holder is described.

Acids and Bases

THERE are two general theories of acidic and basic function. The first, generally known as the Lowry-Brönsted theory, is represented by the scheme $B + H^+ \rightleftharpoons BH^+$, where H^+ is the proton (an acid being defined as a source of protons) and B a base (for example, a weak acid anion, OH^-, an amine, etc.). In the second theory, proposed by G. N. Lewis (1938), a base is a species having a free electron pair which can enter the shell of another atom, and an acid a species which can accept such an electron pair: $A + :B = A:B$. This introduces no new bases but it insists that the proton is only one of many species which can accept an electron pair and so combine with a base, and such molecules as BCl_3 are regarded as acids. G. F. Smith (*J. Chem. Soc.*, 521; 1943) has pointed out that the hydrolysis of the chloroacetate ion, investigated by H. M. Dawson, E. R. Pycock and G. F. Smith (*ibid.*, 517), and of the bromoacetate ion, is subject to general basic catalysis, and the Brönsted catalysis relation holds for a series of basic catalysts, but not for certain cases. In the reactions no proton transfer can be involved, and this is in agreement only with Lewis's definition; the Lowry-Brönsted definition appears to be too narrow.

EDUCATIONAL RECONSTRUCTION IN INDIA

AT the thirty-first Indian Science Congress held in January, the presidential address delivered by Mr. John Sargent before the Section of Psychology and Educational Science deserves more than a passing notice, because of the practical and comprehensive manner in which he dealt with the enormous problem of educational reconstruction in the Indian Empire.

Mr. Sargent began at the very beginning by asserting that the cause of real education has not been helped by "the tendency of woolly-minded philosophers to assume that education with a big E is necessarily a good thing". The totalitarian countries, he points out, have given a timely reminder that education can be as powerful a means of corrupting as of improving the mentality of a nation. But it has always been an instinct of human nature to want to know about things, both to satisfy curiosity and to ensure the preservation of the race by enabling it to assert control over its environment. No free nation which has once had a system of education would submit to be deprived of it. The Indians, of all people, need it, because they now range themselves among the United Nations, pledged to the ideal of democracy, and "democracy, like education, is not necessarily a good thing. It is the sort of democracy that matters." If a little learning in an individual is a dangerous thing, a little learning in a nation is not less dangerous. An India, "85 per cent of whose population are illiterate and liable, as we have seen in recent years, to be stampeded by political or religious excitement, however irrational, constitutes a field for mischief-makers". In other words, India owes it to her allies the world over to overhaul her educational provision thoroughly. "Whatever may satisfy government or big business or all the other vested interests whose vision is oblique or retrospective, the logic of any post-war settlement will demand a drastic change in the present state of things".

Upon such a foundation of principle, Mr. Sargent proceeded to raise a superstructure of Indian education as, in his belief, it ought to be, and in course of time can be. His minimum programme is comprised under a dozen headings, familiar to an English reader. They include compulsory and free schools from five or six to fourteen years of age, a reasonable supply of nursery schools, secondary schools of different types, university education for picked students, technical, commercial and art education, adult education of all kinds and standards, teachers' training institutions, special schools, recreational facilities, employment bureaux, and an efficient system of administration. Judged by the system in Great Britain, this is not an extravagant programme. Mr. Sargent then turned to consider how far the Indian system, as it exists to-day, falls short, and whether it is practicable to build upon it a national system on the lines suggested.

Mr. Sargent takes each item of his minimum programme, and deals with it faithfully. Less than one out of every four children stay long enough at school to attain "permanent literacy", so that the money spent on the others (nearly 80 per cent) may be regarded as wasted. In India, as elsewhere, only a tiny part of the vast army of teachers required enter the profession because they feel called to it; the rest must be attracted by decent prospects of a living, and there India has an immense problem. Of buildings and equipment, at any rate in the lower stages, "the less said the better". There is an obvious need for a youth movement on an All-India scale; and so on through a rather depressing catalogue, which, however, does not prevent Mr. Sargent from courageously facing the problems of finance. There is, he says, reason to hope that "as education spreads among the rural population it may lead to the abandoning of those superstitions and prejudices which for centuries have hung like millstones round the neck of the Indian peasant". A competent observer has estimated that with the removal of these, the standard of living among agriculturists might be raised by as much as 100 per cent. "Given the will and given the funds," concludes Mr. Sargent, "it would in my opinion take at least 35 to 40 years to establish the sort of system outlined in this paper."

The outlook for India, as thus presented, seems by no means depressing. Vast India may be likened to a lot of little Englands put together, and in the England of a century ago illiteracy was nearly as common as it now is in India, and most forms of education did not exist or were struggling for life.

T. RAYMONT.

BASICITIES OF THE AMINOQUINOLINES: COMPARISON WITH THE AMINOACRIDINES AND AMINOPYRIDINES

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IN view of the use that has been made, in recent years, of the aminoquinolines as intermediates in the evolution of new drugs, it is surprising that no measurements of their strengths as bases have been published. Briefly, the history of these drugs is that the antimalarial, pamaquin, introduced in 1926 under the trade-name of 'Plasmoquine', was the first chemotherapeutic substance derived from an aminoquinoline; in 1937 three more aminoquinoline drugs appeared, namely, the wound-antiseptic 'Surfen' and the trypanocides 'Surfen-C' and Bayer 7602, the latter being intended as a specific for *T. cruzi* infections in South America. Later, 'Acaprin', another aminoquinoline drug, became established as a specific for certain piroplasmoses. In Moscow in 1937, Maghidson and Rubstov[1] discovered some malarial schizonticides in this series[2], but the development of new aminoquinoline drugs has taken place mainly in Germany: Iensch[3], even in 1937, was able to review the structure and activity of some hundreds of these compounds, and work of this kind has apparently gone on steadily[4].

The dissociation constants of the seven isomeric aminoquinolines have now been determined and are compared in Table 1 with the dissociation constants of the corresponding aminoacridines and aminopyridines. Because the acridine nucleus is numbered differently from the others, the table has been arranged with analogously substituted compounds opposite one another.

The favourable solubilities of the aminoquinolines has facilitated potentiometric titration of these substances in water (glass electrode; 0·001 gm. mol. in 60 mils). For comparison we reprint our results for the aminoacridines in 67 per cent methanol, since the sparing solubility of these compounds stands in the way of their accurate determination in water. As Mizutani[5] has indicated, pK values obtained in methanol of this strength are 0·3–0·9 unit too low, and hence a better approximation to the true values may be had by adding 0·5 unit to the aminoacridine results quoted here than by relying on figures obtained in water under conditions of non-equilibrium[6]. The three aminopyridines are freely soluble in water and we have taken the basicity figures (conductimetric) from the literature.

the analogously constituted 2-aminoacridine indicates that it, too, is rightly placed in class iii.

What is the cause of these exaltations in basicity? In 1941 we suggested tentatively that in the acridine series such exaltations are connected with the fact that the isomerides exhibiting this property can be depicted tautomerically as imines; for example, formula I for 2-aminoacridine. In the quinoline series, only the 2-, 4-, 5- and 7-isomerides can be written in analogous fashion, as has been done in formulæ II, III, IV and V respectively.

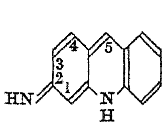
A mechanism by which this possibility of tautomerism affects the basicities of the aminoacridines has recently been worked out[6] and is capable of expansion to include the aminoquinolines and aminopyridines.

TABLE 1. FIRST DISSOCIATION CONSTANTS OF SIMPLE HETEROCYCLIC AMINES.
(Expressed as pK_a, the negative logarithm of the acidity constant.)

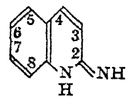
Quinoline series	pK_a in water at 20° C. *	Criterion of purity	Acridine analogues **	pK_a in 67% methanol; 20° C.	Pyridine analogues	pK_a in water
Quinoline	4·94	b.p. 132°/40 mm.	Acridine	4·54	Pyridine	5·21†
8-Aminoquinoline	3·93	m.p. 65°	1-Aminoacridine	3·68	(no analogue)	
7-Aminoquinoline	6·65	m.p 94°	2-Aminoacridine	7 60	(no analogue)	
6-Aminoquinoline	5·62	m.p. 117°	3-Aminoacridine	5·30	(no analogue)	
5-Aminoquinoline	5·51	m.p. 110°	4-Aminoacridine	5·74	(no analogue)	
4-Aminoquinoline	8·46	m.p. 69–70°	5-Aminoacridine	9 34	4-Aminopyridine	9·1 ††
3-Aminoquinoline	4 95	m.p. 94°	(no analogue)		3-Aminopyridine	6·6 ††
2-Aminoquinoline	7·34	m.p. 131°	(no analogue)		2-Aminopyridine	7·2 ††
					ditto	6·86*

* Newly determined by potentiometric titration, glass electrode, 20° C.
** From Albert, Rubbo and Goldacre, NATURE, **147**, 332 (1941); glass electrode.
† From Britton and Williams, *J. Chem. Soc.*, 796 (1935); glass electrode, 18° C.
†† From Tropsch, *Monatsh.*, **35**, 777 (1914); conductimetry, 25° C.

Discussion of results. As with the aminoacridines, the values for the aminoquinolines fall into three groups. Class i, where the pK value is approximately 1 unit *lower* than the value for quinoline, is represented only by 8-aminoquinoline. This tenfold weakening of basicity is evidence of an *ortho* effect as in the analogous 1-aminoacridine[7]. We have not



I



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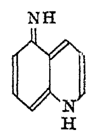

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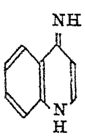
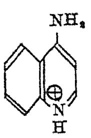
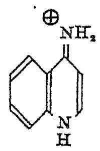


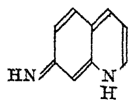
III



IIIa



IIIb



V

yet established in either case whether this *ortho* effect is due to hydrogen-bonding or is simply a steric hindrance to the approach of the hydronium ion. Class ii, where the pK is not more than 1 unit *higher* than quinoline, contains the 3-, 5- and 6-isomerides, which are hence considered as the normal amino derivatives of quinoline. Class iii consists of derivatives which are considerably more basic than quinoline, notably 2- and 4-aminoquinolines, the latter being more than three thousand times stronger a base than quinoline. Although 7-aminoquinoline is only fifty times as strong as quinoline, comparison with

Briefly, the ion of 4-aminoquinoline may be written as III*a*, which is derived from the normal form of the base, and also as III*b*, which is derived from the tautomeric imine III. The two forms of the *base* differ from one another in the position assigned to an atom of hydrogen, and hence, regardless of whether they can exist apart from one another, they cannot (by definition) be resonant with one another. On the other hand, the *ions* theoretically derived from them differ from one another only in the distribution of electrons and hence, provided that not too much of the unionized base's *nuclear* resonance is destroyed in the process (for example, by converting a benzene ring into an *ortho*quinonoid structure), the ions will exhibit a higher degree of resonance than the unionized base. The larger this 'extra ionic resonance energy' is, the greater will be the basicity of the amine because of the increasing tendency to pass over into the more stable ion. This serves to explain the exaltation of 4-aminoquinoline, which can readily change into the ion, which is a resonance hybrid of both III*a* and III*b*. As is usual where a high degree of ionic resonance is present, the second pK is greatly reduced. The exaltation in the analogously constituted 5-aminoacridine and 4-aminopyridine is of the same order.

The ion of 2-aminoquinoline can similarly be considered as a resonance hybrid derived from the normal amine and the tautomeric imine II, which is essentially an amidine. This base is weaker than 4-aminoquinoline because the resonance depends on an *ortho*quinonoid contribution; likewise it is very much weaker than the aliphatic amidines, where the base-strengthening resonance is facilitated by sym-

TABLE 2. 3-AMINOQUINOLINE.

Percentage neutralized	7	13	20	27	33	40	47	53	60	67	73	80	87	93
pK_a value	5·04	5·05	4·96	4·97	4·96	4·94	4·95	4·93	4·92	4·94	4·92	4·94	4·96	5·09

metry and the absence of competition with nuclear resonance[8,9]. In 2-aminopyridine, where all Kekulé-type resonance has been lost in one contributing form, the exaltation is vanishingly small. This diminution in resonance by loss of a benzene ring is seen again in the diminished exaltation of 7-aminoquinoline V, as compared with its analogue, 2-aminoacridine. Finally, no extra ionic resonance is observed in 5-aminoquinoline (corresponding to practically none in 4-aminoacridine). This may well be because an ion derived from the imine IV, in addition to being *ortho*quinonoid (a structure that is relatively unstable and does not readily take part in ionic resonance[10]), must also lose both the Kekulé-type rings of quinoline.

An interesting by-path in these investigations has been the examination of our titration figures for 3-aminoquinoline in order to confirm the existence of the semi-hydrochloride that Mills and Watson[11] postulated on the grounds of colorimetric and cryoscopic anomalies. However, the constancy of the *p*K values obtained on adding one equivalent of hydrochloric acid to the base (Table 2) gives no indication of its formation.

While these simple aminoquinolines do not themselves possess marked chemotherapeutic properties, the main types of basicity discussed here will persist in their active derivatives. For example, pamaquin, a derivative of 8-aminoquinoline and the only aminoquinoline drug yet investigated, has a pK_a of 3·55[12]; similarly, in the acridine series the exaltation seen in 5-aminoacridine persists in its derivatives 'Rivanol' and 'Atebrin'.

Because bases with *p*K values below 6 are less than 10 per cent ionized at *p*H 7, while those with values above 8 are practically completely ionized, a biologically important difference exists between drugs based on different aminoquinolines, and this should not be overlooked in interpreting the action of known drugs and in devising new ones.

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EARTH-FAULT RELAY EQUIPMENT

A PAPER entitled "A Modern Earth-Fault Relay Equipment for use on Systems Protected by Petersen Coils" was read in London recently by L. B. S. Golds and C. L. Lipman before the Institution of Electrical Engineers, and in it the authors dealt with the automatic isolation or indication of earth-faults on such systems. After discussing the operating principle of this type of protection, describing the working of a wattmeter-type relay, and enumerating the electrical constants of the type of system to which the protection is applied, the paper describes the application of the relay to an actual 66-kV. system.

The currents in the feeders are analysed and the problem of accurate current summation is discussed in detail. A comparison is made between current summation by means of a summation transformer and by direct paralleling. Results are given of laboratory tests on current-transformers at currents approximating to the system capacitance currents. Further test figures are given showing the effect of load current in addition to capacitance currents. The design of the relay element, its constructional features and operating characteristics are described.

From experience gained on tests with artificial faults and under actual system earth-fault conditions, the relays were found to be quite reliable in operation, providing the equipment was connected correctly and the current-transformers were sufficiently accurate. When commissioning the gear, an artificial fault is valuable in proving the reliability of the equipment. By observing the operation of the relays at each sub-station with faults at selected points, the complete scheme can be put into operation with a minimum of testing. Preliminary tests are carried out by single- and three-phase injection to ensure that the transformers are balanced and that they comply with the specification.

These relays are being used in conjunction with phase-fault relays to switch-out one faulty line in the event of a double earth-fault, leaving the original fault on the system. The difficulty of extreme sensitivity has been overcome by the use of a resistance in series with the coil, which serves the double purpose of limiting the asymmetric current under healthy conditions and increasing the active component under fault conditions; this has the advantage of making the relay more robust.

FORTHCOMING EVENTS

Monday, April 17

INSTITUTION OF ELECTRICAL ENGINEERS (CAMBRIDGE AND DISTRICT WIRELESS GROUP) (at the Technical School, Cambridge), at 5.30 p.m.—Mr. B. J. Edwards: "A Survey of the Problems of Post-War Television".

Tuesday, April 18

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. Hans E. Adler: "Life in Soviet Turkestan".

BRITISH SOCIETY FOR INTERNATIONAL BIBLIOGRAPHY (at the Science Museum, Exhibition Road, South Kensington, London, S.W.7), at 4.30 p.m.—Mr. H. Thomas: "Co-operative Cataloguing"; Colonel Luxmoore Newcombe: "The Library of Congress Depository Catalogue and Bibliographical Service at the National Central Library".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. D. Caradog Jones: "The Standard of Living".

ILLUMINATING ENGINEERING SOCIETY (joint meeting with the SCIENCE MASTERS' ASSOCIATION) (in the Large Physics Lecture Theatre, Imperial College of Science, Imperial Institute Road, South Kensington, London, S.W.7), at 5 p.m.—Following a short introductory Address a series of Experiments illustrating the Production and Nature of Light, Photometry, the Fundamental Principles of Illuminating Engineering, and the Advantages of Good Lighting will be demonstrated and discussed.

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m.—Discussion on "Metals and their Finishes in Radio Construction" (to be opened by Dr. G. L. Sutherland).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. Y. A. C. Yule: "Unsharp Masks, a New Method of Increasing Definition in Prints".

Wednesday, April 19

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the MICROBIOLOGICAL PANEL OF THE FOOD GROUP, THE AGRICULTURE GROUP AND THE ASSOCIATION OF APPLIED BIOLOGISTS) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 11 a.m.—Papers on "Soil Sterilization". (Dr. W. F. Bewley: "Some Problems in Soil Sterilization"; Mr. W. J. C. Lawrence: "Soil Sterilization and Seedling Growth"; Mr. A. H. Dodd: "Considerations in Chemical Soil Sterilization"; Mr. H. Lees and Dr. J. H. Quastel, F.R.S.: "A New Technique for the Study of Soil Sterilization" (with Demonstration); Mr. H. Lees and Dr. J. H. Quastel, F.R.S.: "Effects of Chlorate Administration on Soil Nitrification").

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. C. Cameron: "Education To-day and To-morrow", 8: "School Broadcasting".

GEOLOGICAL SOCIETY OF LONDON (joint meeting with the INSTITUTION OF WATER ENGINEERS) (at Burlington House, Piccadilly, London, W.1), at 2 p.m.—Discussion on "Sources of Water in relation to Town and Country Planning".

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 p.m.—Address by the President (Admiral of the Fleet the Rt. Hon. Lord Chatfield, G.C.B., O.M.).

ROYAL SOCIETY OF MEDICINE (at 1 Wimpole Street, London, W.1), at 2.30 p.m.—Discussion on "The Limitations and Uses of the Comparative Method in Medicine", 4: "Neurology and Psychiatry" (to be opened by Dr. Dorothy Russell, Dr. J. R. M. Innes, Dr. W. S. Gordon, Dr. W. H. Andrews and Prof. Samson Wright).

Thursday, April 20

MANCHESTER CHAMBER OF COMMERCE (at Houldsworth Hall, Manchester), at 11.30 a.m.—Sir Edward V. Appleton, K.C.B., F.R.S.: "Fundamental Research—its Practical Importance".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. W. H. Mills, F.R.S.: "Old and New Views on Some Chemical Problems" (Presidential Address).

INSTITUTE OF THE PLASTICS INDUSTRY (LONDON AND DISTRICT SECTION) (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Mr. D. N. Davies: "Polyvinylchloride".

ELECTRICAL ASSOCIATION FOR WOMEN (joint meeting with the WOMEN'S ENGINEERING SOCIETY) (at 20 Lower Regent Street, London, S.W.1), at 7 p.m.—Conference on "Women in the Building Industry".

Friday, April 21

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. L. Jacob: "A New Type of Electron-Optical Voltmeter".

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 6 p.m.—Display of Scientific Films by Mr. N. L. Harris and Mr. M. Michaelis.

Saturday, April 22

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Dr. J. Blair Hartley: "The Future of Radiology in Obstetrics".

INSTITUTE OF PHYSICS (INDUSTRIAL RADIOLOGY GROUP) (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. H. Glaisher, Dr. W. Betteridge and Mr. R. Eborall: "The Mottling of Aluminium Alloy Radiographs".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE DEPARTMENT OF ELECTRICAL ENGINEERING—The Principal, Harris Institute, Preston (April 20).

LECTURER IN INORGANIC OR PHYSICAL CHEMISTRY to Higher National Certificate or Degree standard—The Principal, Royal Technical College, Salford 5, Lancs. (April 21).

GRADUATE LECTURER IN MECHANICAL ENGINEERING, a GRADUATE LECTURER IN ELECTRICAL ENGINEERING (preferably with experience in RADIO), and a GRADUATE LECTURER IN CHEMISTRY (with subsidiary MATHEMATICS, PHYSICS or BIOLOGY), at the Southend Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea (April 22).

SENIOR SPEECH THERAPIST—The Director of Education, Education Offices, Nelson Square, Bolton, Lancs. (April 22).

ASSISTANT MASTER FOR TECHNICAL SUBJECTS in the Municipal Technical College—The Secretary, Education Office, Town Hall, Widnes (April 22).

CHAIRS OF MATHEMATICS, PHILOSOPHY and PHYSICS, tenable at Bedford College for Women—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (April 24).

INSTRUCTOR IN BEEKEEPING (temporary) on the Agricultural Instruction Staff of the Somerset County Council—The Clerk to the Somerset County Council, County Hall, Taunton (April 24).

COMBUSTION ENGINEER to undertake Shift Duties at a large Power Station in London—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2074XA) (April 24).

ASSISTANT ENGINEER by the Great Yarmouth Electricity Undertaking—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.799XA) (April 24).

ASSISTANT MAINS ENGINEER (location, Essex)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.800XA) (April 24).

TEACHER (man) OF MATHEMATICS (with subsidiary SCIENCE) at the Cambridgeshire Technical School—The Education Secretary, Cambridgeshire Education Committee, Cambridge (April 24).

ASSISTANT LECTURER IN CHEMISTRY (with special qualifications in PHYSICAL CHEMISTRY)—The Registrar, The University, Manchester 13 (April 25).

LECTURER IN CHEMISTRY to teach PHYSICAL and INORGANIC CHEMISTRY up to Honours B.Sc. standard, at the Cardiff Technical College—The Director of Education, Education Offices, Cardiff (May 1).

SUPERINTENDENT to take charge of modern factory in South-East Essex producing Soap Products, Glycerine and Fatty Acids—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2091XA) (May 1).

ASSISTANT MASTER to teach MATHEMATICS at any stage up to University Scholarship work at the City of London School—The Town Clerk, 55-61 Moorgate, London, E.C.2 (May 1).

DRUMMOND PROFESSORSHIP OF POLITICAL ECONOMY—The Registrar, University Registry, Oxford (May 13).

ENGINEERING INSPECTOR OF MINES (temporary) in a Government Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2088A) (May 17).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

GRADUATE LECTURER IN MECHANICAL ENGINEERING at the Municipal College, Southend-on-Sea—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

JUNIOR CHEMIST for an Iron Ore Mine in Sierra Leone—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 406).

LECTURER FOR BIOLOGY AND HYGIENE—The Principal, St. Katharine's College, Tottenham, at Cary Park, Babbacombe, Torquay.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Society of Edinburgh. Section A (Mathematical and Physical Sciences). Vol. 62, Part 1, No. 6: Automatic Wave Functions for Ground States of Elements *Li* and *Ne*. By Dr. W. E. Duncanson and Dr. C. A. Coulson. Pp. 37–39. 6*d*. Vol. 62, Part 1, No. 7: *Quantum Mechanics of Fields, 1: Pure Fields*. By Prof. Max Born and Dr. H. W. Peng. Pp. 40–57. 3*s*. Vol. 62, Part 1, No. 8: A Measurement of the Velocity of Light in Water. By Dr. R. A. Houstoun. Pp. 58–63. 1*s*. (Edinburgh and London: Oliver and Boyd.) [133

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 19: The Chemical Constituents of Lichens found in Ireland—*Cladonia sylvatica* (L.) Harm. emend. Sandst. By T. W. Breaden, Dr. J. Keane and Dr. T. J. Nolan. Pp. 197–200. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 6*d*. [143

University of Leeds: Department of Coal Gas and Fuel Industries with Metallurgy. Report of the Livesey Professor for the Session 1942–43. Pp. 16. (Leeds: The University.) [163

Leeds University: University Extension Lectures and Tutorial Classes. Thirty-fourth Annual Report, 1942–43. Pp. 6. (Leeds: The University.) [163

Ollsgoil na h-Éireann: The National University of Ireland. Calendar for the Year 1943. Pp. x+592. (Dublin: National University of Ireland.) [173

Royal Agricultural Society of England. Report of Executive Committee with Statement of Accounts and Balance Sheet for Year ended 31st December 1943. Pp. 24. (London: Royal Agricultural Society of England.) [203

Other Countries

Proceedings of the United States National Museum. Vol. 94, No. 3173: Revisions of Two Genera of Chalcid-Flies belonging to the Family Eupelmidæ from North and South America. By A. B. Gahan. Pp. 339–370. Vol. 94, No. 3174: New Species of American Scolytoid Beetles, mostly Neotropical. By M. W. Blackman. Pp. 371–400 + plates 15–17. (Washington, D.C.: Government Printing Office.) [93

Smithsonian Miscellaneous Collections. Vol. 104, No. 2: Cross Sections of New World Prehistory; a Brief Report on the Work of the Institute of Andean Research, 1941–1942. By Prof. Wm. Duncan Strong. (Publication 3739.) Pp. v+46+33 plates. (Washington, D.C.: Government Printing Office.) [93

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1943. (Publication 3740.) Pp. ix+95+2 plates. (Washington, D.C.: Government Printing Office.) 25 cents. [133

U.S. Office of Education: Federal Security Agency. Bulletin 1943, No. 2: Inter-American Education; a Curriculum Guide. By Effie G. Bathurst and Helen K. Mackintosh. Pp. 66. (Washington, D.C.: Government Printing Office.) 15 cents. [133

Pennsylvania State College: School of Agriculture. Bulletin 452: Conditions Affecting the Digestibility and the Metabolizable Energy of Feeds for Cattle. By E. B. Forbes, Prof. R. W. Swift and others. Pp. ii+34. Bulletin 453: Energy Values of a Group of Silages. By E. B. Forbes, Prof. R. W. Swift and John W. Bratzler. Pp. ii+14. (State College, Pa.: Pennsylvania State College.) [133

League of Red Cross Societies. Hygiene, Medicine, Biology: Notes and Abstracts for the Use of National Red Cross Societies. No. 1, July 1943. Pp. iv+47. (Geneva: League of Red Cross Societies.) [133

Anuario del Observatorio Astronómico de Madrid para 1944. Pp. 334. (Madrid: Instituto Geográfico.) [133

Joint Progress Report on Reservoir Efficiency and Well Spacing. By the Committees on Reservoir Development and Operation of the Standard Oil Company (New Jersey) Affiliated Companies and of the Humble Oil and Refining Company. Pp. xix+77. (New York: Standard Oil Development Co.; London: Anglo-American Oil Co., Ltd.) [153

Dominion of Canada. Report of the Department of Mines and Resources including Report of Soldier Settlement of Canada for the Fiscal Year ended March 31, 1943. Pp. 207. (Ottawa: King's Printer.) [203

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UNIVERSITY DEVELOPMENT IN GREAT BRITAIN

THERE are three main reasons for the attention which is now being concentrated in Great Britain on the development of the universities. In the first place, the quickened interest in education generally, which has led to the introduction of the Education Bill and the widespread approval of the White Paper on Education, induce the consideration of the universities as a part of that system, and their ability to meet the demands of the post-war society. That interest has been strongly reinforced by the growing concern with social problems and the realization of the relation between education and the society whose needs schools, universities and technical colleges have to meet, as the proceedings of the annual conferences of the National Union of Students or the most casual survey of the immense literature on reconstruction will attest. Still further, and more urgently, attention has been focused on the universities from the point of view of their equipment to meet the country's needs in regard to research and of the training of the greatly increased number of research workers which will be required after the War.

On all these counts there is now general agreement that the financial resources of the universities of Great Britain must be much increased, and that in the main this increase must come from Government grants. The urgency of increasing the provision for research at the universities and for training research workers has been stressed in recent reports and discussions on demobilization, while the statement in the report of the Parliamentary and Scientific Committee on "Scientific Research and the Universities in Post-War Britain" could scarcely be bettered. This aspect is receiving the particular attention of the special committee under Lord Hankey, while the extent of the interest in the broad question of university education generally is to be seen in the activities of the British Association Committee on Post-War University Education, which has already issued several reports, and in the prominence given to the question in recent reports on industrial and scientific research, notably that from the London Chamber of Commerce.

A report entitled "University Developments" has now been issued by the Association of University Teachers*, following its adoption by the Council of the Association on December 16, 1943. The British Association Committee has issued a further note reviewing its earlier reports and suggesting a universities council to plan and guide the developments suggested. The same question is still further examined by Sir Ernest Simon in a pamphlet, "The Development of the Universities"†, while Prof. G. C. Field has contributed an important article, "Problems of the Modern Universities", to the April issue of *Agenda*.

Several of these reports and papers admittedly owe

* Association of University Teachers. Report on University Developments. Pp. 16. (Bristol: J. W. Arrowsmith, Ltd., 1944.) 1*s*.

† The Development of the Universities. By Sir Ernest Simon. Pp. 20. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1944.) 1*s*. net.

something to one or other of three recent books on the universities, notably to Bruce Truscott's "Red-brick University". F. R. Leavis's "Education and the University" is concerned more specifically with the organization of a School of English as a real humane focus capable of discharging the function of a university in the matter of liberal education. Brian Simon's "A Student's View of the Universities", admittedly a *cri au cœur* and revealing the trend of thought among student members, adds little to the discussion that could not be found in H. C. G. Herklot's "The New Universities" in 1928. The specific problems of the Scottish universities have since been discussed from the student's point of view by J. H. Burns and D. Sutherland Graeme in a still more recent book, "Scottish University".

The questions discussed in this mass of literature vary widely in importance and urgency. They range from details of internal discipline, amenities, organization, scholarships and examinations, to the ultimate functions of the universities and their relations to one another and to the State. In so far as they are raised by the immediate proposals for university expansion, they may be placed, according to urgency or timing, in three main, though overlapping, groups : those of function, such as the relations between the universities and society, their regional responsibilities, or the balance between research and teaching ; questions of organization, such as the size and distribution of faculties and research schools, the administration and distribution of grants, and the external relations of universities with one another and with the State ; and finally, internal problems such as the status and salaries of academic staff, scholarships and fellowships, the provision of medical and social facilities for students, halls of residence and the like.

There are first the fundamental questions as to the functions of the universities and their place in the society of to-day. Unless we have clear ideas as to the functions the universities are to serve, we cannot assign them their right place, either in the educational system, in our organization for research or in society as a whole. Without such ideas their interrelations and organization cannot be profitably considered or the available national resources wisely apportioned. The necessity for clarifying our ideas on this question is well emphasized by such suggestions as the creation of a British university for the printing and allied crafts which was recently seriously advanced in a reputable technical periodical.

While such a challenge to fundamental thinking is urgent and cannot be ignored, this group of questions is not of first importance at the present time, and is rather of the long-term type. Creative thought cannot be forced, and all we can expect to achieve in the near future is such rebuilding of our educational framework as is necessary to stimulate the creative forces and to encourage experiments in accordance with the needs of our age of transition. What should be kept in mind is that the changes introduced to meet the immediate and urgent needs should not be such as to impede more far-reaching changes or developments which further inquiry and investigation may indicate as desirable. Our immediate measures should be such as to provide the largest possible amount of evidence as to the direction and magnitude of any further changes. The loosening of structure, to which the universities like all other social institutions have been subjected during the War, should assist the promotion of such experiments, and enforce the lesson that all social institutions must be regarded as dynamic rather than static if they are to remain in vital touch with the society they profess to serve.

The most urgent problems involved in the expansion of the universities to meet the immediate post-war needs in regard to the training and re-training of demobilized men and women, and the provision of the increased numbers of research workers and other scientific workers and technicians and of the facilities for fundamental research, are those of the second group. University expansion could well be handled so as to provide the experience and guidance for ultimate decisions as to appropriate size and numbers of our universities, their relation to the technical colleges, the balance between research and teaching, the content and scope of curricula, the relations between the State and the universities, the nature of internal organization, and the mechanism of endowment and entry. On many of these questions it is doubtful if we have sufficient data for final decision, and there is an admirable note of caution sounded by the more constructive critics, as in Prof. Field's article and in Dr. Löwe's "The Universities in Transition", in regard to such matters as the residential system, the lecture or the tutorial system, on which there has been a tendency in some quarters for rather hasty generalization and action which might prove too drastic or even unnecessary.

These questions are approached by the Association of University Teachers on four unexceptional principles. First, an essential function of the universities is the pursuit of knowledge untrammelled by any private or corporate interest. This is part of that wider freedom of expression of opinion on all matters of public concern which university teachers claim as their right as citizens. Their function of teaching is equally essential, and the universities in their instruction must embrace training in methods of thought and research as well as factual information. Third, the universities are schools of communal living in which the development of students as individuals is equally important with their development as social beings. Finally, the universities are part of society and bear a direct responsibility to it. They must therefore study the application of organized knowledge to practical problems, and train men and women for particular tasks.

Leaving for the present the observations of this report on questions falling in the third group, such as entry to the university, including both the entrance examination and the degree courses, we may note that the Association reckons on a 50 per cent increase of the student population of Great Britain—which would still leave the ratio of students to population in England and Wales considerably lower than that in some countries, according to 1934 figures—and that it emphasizes the urgent social need for a larger flow of trained and educated citizens. Its observations on

the structure of the universities and on co-operation between the universities, however, open in further detail a subject on which the recent reports of the London Chamber of Commerce and the Parliamentary and Scientific Committee have touched from one particular point of view, and to which Sir Ernest Simon devotes the major part of his pamphlet. The Association approaches this question with the object of determining what changes should accompany the expansion of the universities, which inevitably must mean closer co-operation between the universities and the outside world. Only by the growth of responsible self-government, the Association believes, can the universities meet both the opportunities and the dangers of the future, and whatever changes are made, liberty of thought and self-expression is an essential condition of progress.

First, as regards internal organization, the Association is much less forthright than Prof. Field, who sees no valid reason for the continuance of the council of a university and would go so far as to eliminate the local grant, except for specific purposes. He does not fail to recognize that universities may have special duties towards their own regions but, like the Association, he insists that much of the work of the universities has no specific regional bearing. The Association of University Teachers, however, considers that the present representative character of university courts and councils is appropriate to the present situation and stage of development of the regional universities, and contents itself with a plea for adequate representation of the academic staff on the council.

It might perhaps be too much to expect the Association's report to be as outspoken in such matters as Bruce Truscott in "Redbrick University", or as Prof. Field, but it is clear that the question merits much more fundamental consideration. In principle, the universities should undoubtedly be self-governing communities of teachers and research workers, and as Prof. Field points out, the present system cannot be rationally defended except on the grounds that it is already in existence. Probably the only reasonable line of advance is that which he suggests, and which is in accordance with the trend of the recommendations of the Association: the gradual extension of academic representation on the councils until the latter become predominantly academic bodies, and the recognition of the academic bodies as possessing the decisive voice in the elections to chairs.

The external aspects of university organization—their relations with the State—are, however, even more important at the present time. The report of the Association here frankly recognizes the need for co-ordination or planning of university development. First, it suggests that the number and size of universities require consideration. In size a university should range from 2,000 to 5,000 students, providing residential accommodation is available for a large number of students; and the first aim of a national university policy in Great Britain should be to build up the smaller universities to this size and to transform some of the university colleges into true independent universities.

Neither the University Grants Committee nor the Committee of Vice-Chancellors and Principals is regarded as competent to deal with all the problems arising out of future university development, which demands a closer association of the universities than hitherto; and it is proposed, therefore, that an academic council be set up by the universities, large and representative enough to be competent to discuss the work of the universities from all sides, and empowered to send recommendations to the University Grants Committee. Such a method is considered a surer and more efficient method of promoting the well-being of the universities than the plan of attaching their policy to a particular Department or Minister of State. The universities touch the life of the community at so many points that if they are, as a whole, to have direct access to the Government, the most appropriate channel might be the Privy Council.

Much the same point is made in the report of the British Association Committee, which suggests that the University Grants Committee might function as a committee of the Privy Council instead of, as at present, directly under the Treasury. The principal feature of this report, however, is its support for the proposal for a universities' advisory council previously advanced by the Parliamentary and Scientific Committee, and also for the view that the council should be entirely free from Government control. Such an advisory council should include the vice-chancellors of the universities and the principals of the university colleges, teachers of various grades in the universities and persons of distinction, for example, from industry, agriculture, medicine, education and government services. The council would require a full-time paid chairman and other staff, partly to assist in statistical inquiries. It would appoint committees to deal with various aspects of university life and with particular departments of university teaching and research, to which specially qualified persons could be co-opted. With such assistance, the council would be able to formulate a national policy of education and research, consider and report on all the national and international aspects of British universities and advise the universities.

A further function of the universities' advisory council might be to organize an annual conference of universities, which any teacher or research worker or administrative officer of any British university could attend, and at which various aspects of university policy could be discussed. A most important function of such a council would be to make representations on the financial needs of the universities to the University Grants Committee, or to any other appropriate body which might be appointed to advise the Government in that field, or a part thereof, as, for example, research. Such a council would also form the appropriate link with universities in other countries and such bodies as the International Education Organization, at first perhaps through the United Nations Relief and Rehabilitation Administration, in dealing with the development, including the reconstruction and rehabilitation, of post-war universities.

The statement in this report owes its inception to a statement by Sir Ernest Simon, who has further detailed his views in his more recent pamphlet, which

sets forth convincingly the limitations of existing machinery. He argues that, as a result of the absence of any national body responsible for studying the work of the universities as a whole, and considering how far all essential fields of thought are covered, there is sometimes redundancy, and sometimes a dearth in the facilities for teaching and research in important subjects, apart from the frequent delay of many years between important new developments and the time when their effective study in the universities is commenced. As examples, Sir Ernest points to aeronautical engineering; no university engineering school in Great Britain is equipped for aeronautical research on a substantial scale. Again, not one of the eight schools of mining is on a really adequate scale: between them they turn out twenty graduates annually, while six university forestry departments yield between them not more than twenty-five graduates a year.

Such disparities seem to make it of first importance that some suitable machinery should be established to study these questions and to ensure that any further increases in the university grant shall be wisely distributed in the best interests of the nation as a whole. Sir Ernest Simon, it is true, pays a warm tribute to the success of the University Grants Committee in distributing a large Government grant without any interference with the essential freedoms of the universities. None the less, he gives a convincing demonstration of the limitations of the present Committee, as well as of the Vice-Chancellors' and Principals' Committee and the Universities' Bureau, in regard to staff and functions and machinery. Substantially stronger staffs are essential for all three bodies if they are to increase their responsibilities to cover the needs which are now indicated.

Sir Ernest advances the suggestion that the University Grants Committee should co-ordinate the work of the Department of Scientific and Industrial Research, the Medical Research Council, the Agricultural Research Council, and the Royal Society, and itself allocate substantially larger grants to research in the various universities in whichever may be decided to be the best method. For example, he suggests that the University Grants Committee should appoint an Engineering Advisory Committee, and instances the question whether a strong school of chemical engineering should be established in Manchester as one which, like the development of chemical engineering abroad, is eminently suitable for consideration by a national body. The University of Manchester is at present studying the best lines of development and co-ordination of its two Schools of Engineering, one at the University and one at the College of Technology, each with two professors. A national advisory committee might well suggest the establishment of a chair of chemical engineering with a strong research department and recommend an appropriate grant for this purpose from the University Grants Committee.

Similar advisory committees would be necessary to deal with the principal subjects, especially with those which involve a substantial amount of research and of plant for research purposes. Other committees might deal with such problems as student life and welfare, halls of residence, the regional development of the civic universities, and the whole question of the relations with foreign, Dominion and Colonial universities. Such committees, with whole-time paid secretaries, of wide experience as well as of sound judgment, should provide an effective means of associating younger persons with the work of the University Grants Committee and thus meet a criticism which has been advanced against it.

Strengthened in such ways as these, Sir Ernest Simon proposes that the Universities Grants Committee should be competent to allocate capital grants to individual universities for specific purposes; to allocate annual grants to individual universities for certain purposes; and to give much more informed advice and help to the universities. These proposals should help the universities of Great Britain between them to cover as effectively as possible the whole field of university work. The old grant and most of any increased grant would still be given as a block grant to each university, and there would be no interference with the complete autonomy of the individual universities, either in the management of their own affairs or in undertaking new developments which they are able to finance from their general grant or in other ways.

It will be seen, therefore, that, contrary to the note issued by the British Association Committee, Sir Ernest leans to a reconstituted and strengthened University Grants Committee rather than to a universities' advisory council, nor does he appear to favour the formation of a separate body for the co-ordination of research, as is suggested in the report of the London Chamber of Commerce. There may well be considerable practical difficulties, as Prof. Field notes, in establishing any representative academic body of the type suggested by the British Association Committee without making it too large to function. The tributes uniformly paid to the work of the present University Grants Committee are further ground for believing that Sir Ernest Simon's proposals in his pamphlet are the most promising line of advance at the moment. Even if further machinery should ultimately prove desirable, there can be little doubt that the University Grants Committee, strengthened in the way indicated, should provide a large measure of the guidance and co-ordination that will be required in facing not merely the immediate post-war needs but also the ultimate and long-range problems of university expansion in regard to both teaching and research.

Not the least of the merits of Sir Ernest Simon's pamphlet is the way in which, in an appendix illustrating the need for national planning in this field, he sets forth the questions to which answers have to be found. Most, if not all, of these questions have been asked in recent books and reports already quoted. To some of them, notably in the report of the Association of University Teachers, answers have already been more or less tentatively given. To many of them, it is clear, some national body must supply the authoritative answer. Manchester and other universities are now facing many of these ques-

tions and seeking answers, but it is implicit in Sir Ernest Simon's pamphlet that guidance from a national body would not only be welcomed, but is indeed essential if appropriate action is to be secured. Such questions as the order of magnitude of university expansion, whether this is to be secured by expanding existing universities or by developing university colleges to university status, clearly cannot be determined by individual universities alone, nor can the regional problems and those of the extent and size of the different schools or fields covered at individual universities be considered without some regard to national resources.

These are all questions which require answers before any increased resources can be wisely apportioned. If there is to be no undue delay, if false steps are to be avoided which might impede progress at a later date, it surely appears wise to use machinery the competence of which, even if in a more restricted field, has already won respect, than to establish an entirely fresh organization for which support must be won anew. While that machinery is dealing with the immediate problems, there should be time to consider those more fundamental questions as to the ultimate functions of a university, the balance between professional and vocational training and training in citizenship and in leadership. and the place of the university in the society which it serves. In the long run, the answers to these questions must determine the content, the scope and the length of university courses and the status of the staff. No one, however, who has studied the quinquennial reports of the University Grants Committee can doubt the capacity or vision of that Committee or that, reconstituted, it could become a centre of stimulus and creative thought in those great matters to which many minds are turning with fresh hope and zeal. It may well be hoped that these reports will do something to stimulate among university graduates generally the interest and thought that must precede any attempt to remedy the conspicuous weakness of most modern universities in Great Britain—the slight opportunity for their graduates to express their opinions on conditions of university life and study, and to participate actively in university affairs.

A HISTORY OF EPIDEMIC DISEASES

The Conquest of Epidemic Disease

A Chapter in the History of Ideas. By Charles-Edward Amory Winslow. Pp. xiii+411. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1943.) 30*s*. net.

THE epidemic diseases occupy much of the space in medical treatises of the Early and Middle Ages. The reason is not far to seek, for plagues and pestilences were common and the resultant decimation of populations at regular intervals was terrifying and impressive.

The conception of the causes of epidemic diseases has varied from age to age. Dr. Winslow has portrayed in this book the evolution of thought and reasoning on epidemiology by giving extracts from the works of the principal participants in this long and unfinished study.

In the earliest times demons figured largely in the etiology of the diseases, and in the primitive races their influence is still largely credited. Out of this belief came the use of charms against disease, witchcraft and exorcism. Even in so-called civilized countries demonology and magic continue to this day to be widely practised, though often cloaked under other names. In 1929, at York in Pennsylvania, a man was murdered by another who wished to have a lock of his hair to use as a charm. The coroner in this case is quoted as saying, "At least half the 60,000 residents of the city of York believe in witchcraft and as for the county's rural population of 90,000, they not only believe in witchcraft, but guide the minutest details of their lives by it".

The next conception was that of the wrath of God, when disease was seen as a punishment for sin. In the Old Testament the propitiation of devils is forbidden. Under the heading of metaphysical medicine, the author illustrates such ideas as astrological influences, the doctrine of signatures, and repellency, or the sending away of disease by means of animate things.

It was not until the advent of Greek science that reasoning began to triumph over superstition. In the age of Hippocrates three major factors in epidemic disease were postulated. First, an epidemic constitution of the atmosphere; secondly, individual predisposition; and thirdly, certain diseases were recognized as contagious and association with the afflicted was known to be dangerous.

The reality of contagion was sharply brought to notice in the fourteenth century by the Great Plague, and the object lesson was reinforced by experience with leprosy and syphilis. It is interesting to note that the relation between plague and disease in rodents was described in early Hindu scriptures.

Hieronymus Fracastorius, as is his right, is given a chapter to himself in which are extracts from his poem on syphilis and from his more important work on contagion.

In the seventeenth century came the conception of animate contagion. Kircher postulated the theory of transmission of disease by living organisms. He was not the first in this field, but his ideas were more concrete than those of his more fanciful predecessors. Leeuwenhoek with his microscopes was also of this age.

After Sydenham and Mead comes Rush and his investigations of epidemics of yellow fever in the late eighteenth century in America. The nineteenth century filth theory of disease was the doctrine of miasms modernized. Sanitary and housing details of this age are described in horrid detail. The change from the miasmatic to the contagion theory of epidemic disease is illustrated by the works of Panum on measles, of Snow on cholera, and of Budd on typhoid fever.

Pasteur ushered in the modern age, and our knowledge of epidemic diseases was brought nearer to completion by an understanding of the carrier state and of insect hosts.

Dr. Winslow's scheme of unfolding this story through the medium of the words or works of the actors in the drama succeeds admirably in being at once easily readable and complete enough to serve as a useful book of reference. There is a full bibliography and index and the book is well bound and printed. J. MARSHALL.

MILK DISTRIBUTION

This Milk Business

A Study from 1895 to 1943. By Arthur Guy Enock. Pp. xi+243+xii—lii+13 plates. (London: H. K. Lewis and Co., Ltd., 1943.) 18*s*. net.

THIS argumentative book covers a wide field, a field almost as large as the milk industry itself; and as in the industry, so in the book, science and prejudice, sound sense and special pleading, clear vision and obscurantism, jostle one another. Although the author somewhat disarmingly assesses the book as an endeavour "to bring interesting and helpful things to light, and to aid in the movement for higher efficiency", and again "as a confession of faith from a convinced believer in the high value of milk", yet since substantial portions of the book are concerned with technical matters bearing on the important subject of the heat treatment of milk, it is legitimate to apply to these portions of the book the usual standards of scientific appraisal.

Mr. A. G. Enock has been interested in refrigeration problems, in the manufacture of dairy machinery and in dairy engineering generally for more than forty years. As a dairy engineer he has seen the development of heat treatment of milk in Great Britain almost from the beginning. He introduced some years ago a process which had been experimented with in the United States—the 'in-bottle' method of pasteurization. By this method, milk is heated to 'holder' pasteurization temperatures (that is, between 145° and 150° F.), and is run at that temperature into the bottles in which it is to be distributed. The latter are sealed and are then kept between the two temperatures for the necessary 30 minutes holding period before cooling. The resulting pasteurized product has remarkable keeping qualities, since post-pasteurization contamination of the milk, which frequently occurs (though it is not difficult to prevent) in ordinary pasteurization plants where bottles are filled with milk by a separate operation *after* pasteurization, is completely avoided.

From the consumer's point of view there is no doubt that this is an excellent method of heat treatment, but it has certain drawbacks from the distributor's point of view. Some of these have been overcome by Mr. Enock in his latest 'in bottle' plant, but this plant still occupies a great deal of space—a criticism that is applicable to most 'holder' plants—it has to run for the greater part of an hour before the first bottles are available for distribution, it is costly, and mechanical difficulties, though fewer now than formerly, are not yet eliminated.

Mr. Enock's main thesis is the supreme excellence of this particular method of pasteurization. He is not content, however, with making a good—perhaps too good—case for the method with which he has been so closely associated, but goes on to criticize rather bitterly the rival method—modern high-temperature short-time ('H.T.S.T.') pasteurization, in the development of which dairy engineers no less competent than himself have spent much effort and which is being used successfully in many parts of the world—on grounds which are sometimes dubious, and supports his arguments by *ex cathedra* statements some of which are ill founded. One of his principal grounds for criticism is that he considers that 'H.T.S.T.' pasteurization has been accepted, and the legal standards for it laid down, on an insufficient scientific basis. Actually the basis is a great deal wider than the ordinary reader of this book is told. The author scarcely refers to the large amount of American work on the subject, and makes little mention of British and Continental work. He may, of course, be unaware of the quantity of information, some of it unpublished, that had accumulated before the Ministry of Health laid down in 1941 the present legal standards for H.T.S.T. pasteurization. To suggest, as the author does (p. 140), without quoting evidence, that sinister influences affected the Ministry's decision, is of subjective rather than objective significance, and to state (p. 150) that there is no evidence to support the belief that H.T.S.T. pasteurization at the temperature and time now legally adopted (milk exposed to at least 162° F. for at least 15 sec.) accomplishes the destruction of disease-bearing organisms which may occur in milk is to contradict the facts.

It would not be fair to the author to leave the impression that the book is not ably conceived and ably written, or that it suffers from anything more serious than occasional lapses, though some of these lapses, if taken at their face value by the uninitiated, might have unfortunate consequences. For anyone with a knowledge of the dairy industry, the book's presentation and arguments cannot be other than interesting and entertaining and in part, as this brief review has demonstrated, provocative.

While a large portion of the book is given to the discussion of pasteurization methods, it also contains valuable data and observations on milk production, and a thoughtful chapter on the future of "this milk business". Biographical and autobiographical touches and extracts from private correspondence add a certain lightness and provide some basis for the rather quizzical title.

H. D. KAY.

GEOLOGY FOR ENGINEERS

A Geology for Engineers

By F. G. H. Blyth. Pp. viii+302+16 plates. (London: Edward Arnold and Co., 1943.) 21*s*. net.

ENGINEERING covers such a wide field that students find little time available for courses which are outside the main scope of its studies. It can be argued that it is of benefit to those pursuing any vocational training to study some subject which tends to widen their interests, and from this point of view geology has many advantages, since most engineers are brought face to face with its teachings in areas and countries to which their vocation leads them. For this purpose the subject should be presented in an interesting form relieved so far as possible from the jargon which has gathered around it, in common with every other scientific subject at the present day.

It is admitted, too, that some knowledge of geology is of direct assistance to civil and mining engineers, and in most engineering schools students are required to take a course in geology which is given by teachers in a geological department. This is quite proper, since only those instructors who have practical experience in the field can adequately present the facts and principles of the subject. It is not always, however, that in such courses the special requirements of the engineer are kept sufficiently in mind. A great deal of the content of the subject which is useful or essential for a geologist to know is of little interest to an engineer, and he feels that the time which he has to devote to it is largely wasted. It becomes for him one more subject to be crammed as best he can.

It is not possible to impart to an engineer such a knowledge of geology as will enable him to appreciate or deal with various geological problems that he may be confronted with in practice. He should, however, know enough to recognize when he is faced with a problem in which geological advice is essential.

Two thirds of this text-book is an elementary course of geology including petrology and mineralogy but excluding palæontology. It is presented in too condensed a form to serve as a cultural study and, on the other hand, is too abstruse to be of direct service to an engineer. It is difficult to see the usefulness to such a student of a knowledge of minerals like antigorite, axinite, celsian, dickite, to choose a few at random, or such rocks as brucite marble, wollastonite marble, teschenite or the deep sea red clay, or again such structures as the ring dykes and cone sheets of the west of Scotland. All such matter and much besides could well have been severely pruned in the interest of the engineer.

On the other hand, the section on the use and interpretation of geological maps could well have been expanded, though the best manner of imparting this knowledge is in practical classes, where actual geological maps on various scales are handled rather than the outline maps habitually used in the instruction of geological students.

Only the latter third of this book is devoted to certain aspects of geology as applied to engineering. These include the geology of water supply, of reservoirs and dam sites, and of cuttings and tunnels, which are well presented though they might with advantage be somewhat fuller.

It is noteworthy that only a minute fraction of the information contained in the first two hundred pages of the book is necessary in order to understand the section devoted to engineering problems.

Of late years, engineers have begun to be interested in a branch of civil engineering called soil mechanics, and in the applications of geophysical methods to engineering problems. Mr. A. W. Skempton, who is an acknowledged authority on soil mechanics, has contributed an appendix on this subject which is one of the most useful parts of the book. An appendix on geophysics is supplied by Dr. Bruckshaw, while a third appendix is devoted to a useful list of the publications of the Geological Survey of Great Britain.

O. T. JONES.

BRITISH TIMBERS

British Timbers
Their Properties, Uses and Identification; with Notes on the Growth and Cultivation of the Trees. By E. H. B. Boulton and B. Alwyn Jay. Pp. 112+31 plates. (London: Adam and Charles Black, Ltd., 1944.) 12*s.* 6*d.* net.

THIS book, with ninety-four pages of text, sixty drawings of transverse and tangential sections, and thirty-one plates showing the plain, quartered and transverse sections of British woods, should prove useful to architects, engineers, builders, and others who are employed or interested in the uses of timber. The little volume embraces all phases—from the seed to the mature tree and the timber.

The planting of trees in England, which in earlier years attracted the interest of a wide section of the people, insensibly diminished year by year until, as the authors say: "The extremely important part played by home-grown timbers in the world war has resulted in a revival of interest in our own woods, and an accompanying demand for information about them". The period between the War of 1914–18 and the present War witnessed an improvement in the public attitude, but not nearly of sufficient consequence to meet the terrible demands of the years 1939–44.

The qualities of British grown timber, and its uses, have been neglected for more than a hundred years. This book comes at a propitious moment, meeting a long-existing need.

The general unfortunate impression has prevailed that Great Britain cannot produce timber of useful quality to compete with foreign supplies. We now know this view to be wrong. The outcome of the debate in Parliament, and the report of the Forestry Commission, if they served no other purpose, at least emphasized the fact that as good and better timber can be grown in Great Britain as in any other country of similar climate. Moreover, many illustrations have emerged; for example, the quality of Scots pine (*Pinus sylvestris*) from one estate yielded prime clear boards free of knots, and of a texture equal to the best that has been seen from Finland, and approximating to the quality of Archangel. Douglas fir (*Pseudotsuga Douglasii—P. taxifolia*) can claim similar success in competition with that from British Columbia. Before this War there were few who would have thought it possible for aerial poles to be provided of a height of 95 ft., with a diameter of 9 in. at the top, and from trees not exceeding eighty years old, if as much, but this has been accomplished. Redwood (*Sequoia sempervirens*), of intrinsic quality, as good as that from California, has been grown; but the want of scientific practice of forestry has resulted in the tree producing too many branches, which means too many knots. In England the general lack of information, and the entire absence of this scientific practice for so many years, was partially responsible for the reluctance of the woodworking industry to employ home-grown timber. Perhaps a more serious feature has been the exceedingly high cost of transport, especially railway rates, which have operated differentially, to the disadvantage of home-grown timber. The authors deal with some of these questions, and afford an opportunity for the study and acceptance of an entirely new outlook.

The book contains eight chapters. Chapter 1, "British trees and their Cultivation", is a good outline in principle, giving a working basis for the amateur planter, with information as to type of soil, planting, etc. Chapter 2, on "The Properties of Wood", deals lightly with many aspects, including grain, moisture content, attack by fungi and beetles, durability, seasoning by air and kiln driers, etc. The chapter on the "Identification of Timbers commonly grown in Britain" contains some good diagrams, and should prove useful in identification, perhaps requiring the assistance and confirmation of the photomicrograph. The chapters dealing with "Hardwoods and Softwoods" are comprehensive and well condensed, giving useful and interesting information. While the plates are interesting, it is doubtful, having regard to the cost of production, whether they provide sufficient interest to warrant their inclusion.

Never before in the history of Great Britain have our woodlands been so fearfully devastated, and the first necessity with which we are confronted is their restoration. At the same time, we should learn from the experience of the last few years to adapt our methods so that our home-grown timbers may be employed to the best advantage.

THE NATURE OF THE VITAMIN B_2 COMPLEX*

By F. A. ROBINSON
Glaxo Laboratories, Ltd., Greenford

THE existence of an 'accessory food factor' was first established by Grijns in the Dutch East Indies, who showed that beri-beri is not due to an infection or a toxic agent, but to a deficiency of some factor in the diet, and in 1911 Funk proposed the name 'vitamines' for factors of this type, implying amines essential for life. Afterwards, the 'e' was dropped, when it was realized that vitamins are not necessarily amines.

In 1915, McCollum and Davis named Grijns' beri-beri factor 'water-soluble vitamin B', to distinguish it from the oil-soluble vitamin A, and in 1920 Emmett and Luros differentiated the true anti-neuritic factor, which was heat labile, from a heat-stable substance, which they assumed to be the pellagra-preventive factor; the substances were called vitamin B_1 and vitamin B_2 respectively.

The constitution of vitamin B_1, now known as 'aneurine' in Great Britain and 'thiamine' in the United States, was established in 1936, and the vitamin was synthesized in 1936–37. Liver, yeast and cereals proved to be particularly rich sources. Thanks mainly to the experiments of Peters and his co-workers, aneurine is now known to be concerned with the metabolism of pyruvic acid which otherwise accumulates in the body, and aneurine pyrophosphate is now believed to be the coenzyme, known as 'cocarboxylase', responsible for the conversion of pyruvic acid into lactic acid, though the reaction is almost certainly not a simple decarboxylation. Aneurine is specific in its action, and only a few closely related analogues show any effect on the growth of vitamin B_1-deficient animals.

Once the distinction between the anti-neuritic and pellagra-preventive factors was recognized, attention was directed to the nature of the heat-stable factor. The concentrates at that time available prevented pellagra in human beings, cured black-tongue in dogs, and a form of dermatitis in rats. They also increased the growth-rate of rats, and this property was used for estimating the vitamin.

A few years later, however, it was shown that the effect on the growth of rats was not due to the pellagra-preventive factor, but to a substance which Kuhn and his colleagues isolated in 1933 from eggs, milk and liver, and which they called 'lactoflavin'. It also occurs in yeast, and its constitution was established independently by Kuhn and by Karrer; on being shown to contain ribose, it was renamed 'riboflavin'. It was synthesized by both workers in 1934.

Riboflavin proved to be the prosthetic group of Warburg and Christian's 'yellow enzyme', known also as 'diaphorase', which is an essential link in the oxidation of carbohydrates. The enzyme appears to be riboflavin phosphoric ester linked to a protein carrier. As with aneurine, the association of riboflavin with an enzyme system probably accounts for its specificity, for only the arabinose analogue, and the ribose compounds with one of the methyl groups replaced by a hydrogen atom or ethyl group, possess vitamin B_2 activity.

* Substance of a lecture delivered before the Nutrition Panel of the Food Group of the Society of Chemical Industry on February 9.

Shortly after it had been established that the rat-growth method was not specific for the pellagra-preventive factor, chicks were proposed as test animals, and a concentrate that cured dermatitis in chicks was shown to cure black-tongue in dogs. In 1937, however, Elvehjem and Woolley isolated nicotinamide from a liver extract, and showed that it cured both black-tongue in dogs and pellagra in human beings, but was ineffective in the chick test. It is now recognized to be the prosthetic group of di- and tri-phosphopyridine nucleotide, both of which are dehydrogenases; the former, known as coenzyme I or cozymase, being a hydrogen carrier in sugar fermentation, muscle contraction and tissue oxidation, and the latter, known as coenzyme II, playing a similar part in the dehydrogenation of glutamic acid and glucose. Nicotinic acid proved to be as effective as its amide in the cure of pellagra and canine black-tongue, and a few closely related substances have similar activity. Quinolinic acid, however, and pyrazine-mono- and di-carboxylic acids appeared to be active in pellagra but not in black-tongue.

The recognition that nicotinic acid or amide was the pellagra-preventive factor left the nature of the rat and chick anti-dermatitis factors still unsolved. The rat factor, known as vitamin B_6, factor I or eluate factor, was isolated in crystalline form in 1938 by several groups of workers, and synthesized shortly afterwards; it is now known as pyridoxine. Although its function is unknown, its absence from a diet has always been associated with anæmia. Like other vitamin B factors, it is highly specific.

The chick anti-dermatitis factor, known as factor II or filtrate factor, proved unexpectedly difficult to characterize, pure concentrates not being readily obtainable. Eventually, however, β-alanine was identified as one half of the molecule and this, when combined with the other half, regen rated the active substance.

At about the same time as Grijns was making his observations on beri-beri, Wildiers demonstrated that certain strains of yeast would not grow on a synthetic medium unless a yeast extract was added, and he termed the responsible factor 'bios'. In 1922, Fulmer and Nelson showed that bios was a mixture of at least two substances: they were distinguished by Lash Miller as Bios I and II, and he was later able to show that bios was composed of seven or eight different substances. Bios I was identified by Eastcott as *meso*inositol, and afterwards three of the other bios factors were shown to be identical with vitamin B_1, nicotinic acid and pyridoxine. Bios II was separated into two components, one of which, the so-called 'Bios IIB', was shown to be identical with biotin, and the other, 'Bios IIA', was named 'pantothenic acid'.

The properties of pantothenic acid closely resembled those of the chick anti-dermatitis factor, and in 1939 R. J. Williams isolated β-alanine from pantothenic acid, and Jukes showed that it cured chick dermatitis; finally, it was shown that the chick factor was also a growth-factor for certain micro-organisms that required pantothenic acid. The constitution of pantothenic acid was established soon afterwards, and it was synthesized.

Although it is believed that pantothenic acid is essential for man, it is not yet known what function it performs; but, like the other vitamin-B factors, it is highly specific, and of the many analogues made, including several prepared by Dr. Barnett and the

present author, only one, hydroxypantothenic acid, showed marked activity. There is presumptive evidence, to be referred to later, that pantothenic acid may be a constituent of an enzyme system.

Bios IIB and Bios IIA had similar histories. In 1927, Boas-Fixsen observed a form of dermatitis in rats which had been fed on raw egg-white. This was prevented by a liver fraction afterwards studied by György, who called it 'vitamin H'. The purification of this factor proved to be extremely difficult because of the small amount present in even the richest sources, but it was eventually shown to be the same as biotin, that is, Lash Miller's Bios IIB. The factor in raw egg-white which caused dermatitis is now known as 'avidin', and has been prepared in crystalline form and shown to be a protein-carbohydrate complex. It combines with biotin to form an inactive complex.

The constitution of biotin was recently established, and its synthesis has been reported, though details have not yet been published. A few weeks ago du Vigneaud reported that methyl-imidazolone-caproic acid could replace biotin as a growth-factor for yeast, but not for *Lactobacillus helveticus* (*L. casei* ε).

One result of the investigations, especially in the United States, on the nutritional requirements of bacteria, has been the development of synthetic media in which substances of natural origin, possibly containing unknown growth-factors, are eliminated so far as possible. Such media are used for estimating the vitamin content of foodstuffs and biological tissues and extracts by comparing the growth of suitable organisms, when known amounts of the substance to be tested are added to an otherwise complete medium, with that of similar cultures containing known amounts of the pure vitamin. The use of such chemically defined media in place of media containing crude concentrates revealed the existence of new growth-factors previously unsuspected.

In this way R. J. Williams discovered folic acid, so called because it was first obtained from green leaves, though it is now known to be present also in liver, kidney and yeast. The preparation of pure folic acid has only just been announced, and its constitution is unknown. Concentrates are prepared by adsorption on charcoal, followed by elution and precipitation with lead and silver salts. The final stages of the purification and the properties of the substance have not yet been described. The factor is not only essential for the growth of *Streptococcus lactis*, the organism with which its existence was first demonstrated, but also for many other exacting micro-organisms.

A number of other factors have also been reported in the literature. Hogan and his co-workers, for example, claimed to have isolated by successive adsorption on fullers' earth, 'Superfiltrol', charcoal and 'Amberlite', a factor which they call vitamin B_c. This is essential for the growth of chicks, and was isolated as orange-yellow platelets, the analysis of which agreed with the formula $C_8H_{10}N_3O_3$. A similar factor, having a similar formula, was isolated by Stokstad.

Briggs, Lucky, Elvehjem and Hart obtained two water-soluble factors from liver by adsorption on 'Norit' and 'Superfiltrol'. These appear to be different from folic acid, and one of them, called vitamin B_{10}, was necessary for the growth of chicks, and the other, vitamin B_{11}, for the feathering of chicks. Another factor necessary for chicks was described by Hutchings.

New factors essential for the growth of micro-organisms have been described by Snell and Peterson, Müller and Miller, Peterson and Burkholder, and Happold and his colleagues. Snell, Guirard and Williams discovered a substance which they call 'pseudo-pyridoxine', since it appeared to be produced from pyridoxine; it is a potent growth-factor and interferes with the microbiological assay of pyridoxine.

Mr. Emery and the present author, working in collaboration with Dr. E. C. Barton-Wright, recently prepared from liver a factor which may be identical with folic acid, together with another factor soluble in chloroform, which stimulates the growth of *L. helveticus* and *S. lactis*; this second factor appears to be distinct from folic acid.

Our knowledge of the vitamin B_2 complex has also been extended by investigations carried out on sulphonamides. It was early recognized that sulphanilamide did not kill bacteria in the same way as the older antiseptics, and the clue to the now generally accepted mechanism of sulphonamide bacteriostasis was provided by Woods, who showed that sulphanilamide was antagonized by a fraction from yeast which had many of the properties of *p*-aminobenzoic acid, and by *p*-aminobenzoic acid itself. He put forward the theory that sulphanilamide owes its antibacterial effect to competition with *p*-aminobenzoic acid at the surface of an enzyme essential to growth.

Fildes suggested that *p*-aminobenzoic acid was an essential metabolite for all organisms that are inhibited by sulphanilamide, and pointed out that some sulphanilamide-sensitive organisms can synthesize their own *p*-aminobenzoic acid, which is, therefore, not a growth-factor for these particular organisms, but an essential metabolite. Sulphanilamide, therefore, acts by competing with an essential metabolite. *p*-Aminobenzoic acid is now known to be a growth-substance for a number of micro-organisms, and must, therefore, be regarded as a bios factor. It has also been shown to be necessary for the well-being of certain animals.

Another substance which antagonizes the effect of sulphanilamide is adenine; like *p*-aminobenzoic acid, it is also a growth-factor for certain bacteria. This may be associated with its presence in coenzymes I and II, referred to above, or in nucleic acids.

The essential metabolite theory of the mechanism of sulphonamide activity led to the discovery of other antibacterial substances which are active by reason of competition with growth-factors. Rubbo and Gillespie showed that *p*-aminophenylacetic acid is a growth-factor for *Clostridium acetobutylicum*, for which the corresponding *p*-aminophenyl methane sulphonic acid is a growth-inhibitor. McIlwain found that pyridine-β-sulphonic acid and its amide antagonize the action of nicotinic acid, and that the growth promoted by certain α-aminoacids is inhibited by the corresponding amino-sulphonic acids. Dr. Barnett and the present author, in conjunction with Dr. McIlwain, showed a similar relationship to exist between pantothenic acid and pantoyltaurine for *Streptococcus hæmolyticus* and certain strains of *Corynebacterium diphtheriæ*. The results suggest that pantothenic acid may be part of an enzyme system. Unfortunately, pantoyltaurine proved to be of little value in curing infections in experimental animals, as it was rapidly excreted, and its effectiveness was

educed by the pantothenic acid present in animal issues. A number of other derivatives recently prepared by Dr. Barnett and the author proved to be no more effective *in vivo* than pantoyltaurine.

Woolley and White have just announced that pyrithiamine', an analogue of aneurine in which the hiazole ring is replaced by a pyridine ring, will nhibit the growth of micro-organisms for which aneurine is an essential metabolite. The organisms that required the intact aneurine molecule were more sensitive than those that required only half the molecule, and these in turn were more sensitive to pyrithiamine than bacteria capable of growing in absence of aneurine.

Certain properties of sulphonamides are also linked with the vitamin B_2 complex in another and different way. Sulphaguanidine and succinyl sulphathiazole, which are now used as intestinal antiseptics, produced symptoms in experimental animals similar to those obtained with a diet deficient in inositol, pantothenic acid, biotin, folic acid or *p*-aminobenzoic acid; these symptoms were cured by feeding one or other of these factors. It was then shown that the sulphonamides were destroying intestinal micro-organisms capable of synthesizing these factors, and it follows from this that normal animals are dependent on the vitamins produced by their intestinal flora for maintenance of health. This explained the diverse symptoms that different workers had previously observed from a deficiency of one particular factor, and also why the absence of one factor may produce a multiple vitamin deficiency, for, whether the growth of the intestinal flora is depressed by the feeding of sulphonamides or by absence of one essential factor, a deficiency of several factors will result.

Recently, Najjar and Holt observed that a group of volunteers fed on a vitamin B_1-deficient diet did not develop vitamin B_1 deficiency but, on the other hand, actually excreted vitamin B_1; this was suppressed by administration of succinyl sulphathiazole. This appears to be the first indication that human beings can absorb vitamin B_1 from the intestine, and it raises the question whether other factors may not normally be provided in the same way. It also suggests that vitamin B_2 factors may have to be administered to patients under treatment with these sulphonamides.

Another substance frequently classified with the vitamin B_2 complex is inositol, the first of the bios factors to be recognized. This is now known to stimulate the growth of intestinal bacteria, and its absence also results in the development of fatty livers. Fatty livers are cured not only by inositol, but also by choline, and this substance is sometimes regarded as a member of the vitamin B_2 complex.

Choline takes part in the methylating activity of the liver, though it is not the only substance that can function in this way, and both methionine and betaine can serve as methyl donators. Substances, for example glycocyamine, exist in the body, which will accept methyl groups from methionine or choline; since the reaction is irreversible, this leads to depletion of the body reserves of labile methyl groups, and so to failure of the transmethylating mechanism. The connexion with fatty liver formation is not yet clear.

The use of liver extracts in the treatment of pernicious anæmia is well known, but the isolation and purification of the responsible substance has been rendered more difficult by the absence of a laboratory method of assay, investigators being dependent on clinical trials for following the progress of purification. In spite of this, marked advances have been made, and Karrer recently reported that a concentrate of the antipernicious anæmia factor containing only 35 mgm. of solid had given a clinical response. Mr. Hurran and Mr. Emery, in my laboratory, have now prepared a concentrate which gives an optima reticulocyte and red-cell response at a level of only 5 mgm. Whether the anti-pernicious anæmia factor should be regarded as a member of the vitamin B_2 group is still uncertain.

There is some evidence that for the cure of nutritional and tropical macrocytic anæmias, other substances in addition to the pernicious anæmia factor are required, but the nature of these factors is unknown. Certain experimental anæmias in animals respond to preparations not containing the anti-pernicious anæmia factor; a microcytic hypochromic anæmia in dogs, for example, responded to pyridoxine, and a normochromic normocytic anæmia was cured by a crude concentrate of pantothenic acid, whereas an anæmia and leucopenia in monkeys was cured not only by a liver extract, but also by an extract of brewers' yeast, which does not contain the anti-pernicious anæmia factor. The factor responsible was designated vitamin M, and Totter and Day recently found that it could be replaced partly, though not entirely, by xanthopterin, a purine-like substance first isolated from the wing-pigments of the brimstone butterfly. According to Simmons and Norris, it cures fish anæmia and goats' milk anæmia in rats.

Elvehjem cured an anæmia and leucopenia in monkeys due to administration of sulphonamides by means of a folic acid concentrate, and this has been confirmed by Daft and Sebrell, using pure folic acid.

It is evident from this survey that the substances which have been included, at one time or another, in the vitamin B_2 complex have widely differing chemical structures. Some of these substances, however, are not vitamins in the strict sense of the term; for historically vitamins are accessory food factors essential for the health of men and animals, and it has not yet been proved that vertebrates require some of the bios factors included in this discussion. Nevertheless, the components of the vitamin B_2 complex and of bios overlap to a considerable extent; most of the members of both groups occur in the same natural sources, especially yeast and liver, they are specific in their effects, and most of them appear to be associated with metabolic processes. Indeed, aneurine, riboflavin, nicotinamide and adenine are known to be prosthetic groups of enzymes, and there is a strong presumption that *p*-aminobenzoic acid and pantothenic acid are also constituents of enzyme systems.

It is quite possible that each of the other members of the vitamin B_2 complex may prove to be an essential part of an enzyme essential for the conversion of food into energy. This seems to be the only explanation of the fact that the same growth-factors are required by the highly organized vertebrates and by the very lowest forms of life; such factors must indeed be associated with the most fundamental of biological processes.

In view of the restricted meaning attached to the word 'vitamins', it seems desirable to have available another word to describe the group of substances now under discussion, which includes not only vitamins

as generally understood, but also essential metabolites, growth-factors, and possibly even amino-acids, for example, methionine, with specific actions. The word 'biotics' is now proposed for this purpose; like the word 'vitamins' it connotes 'essential for life', and, moreover, its antithesis, 'antibiotics', is now fairly well established, especially in the United States, to describe antibacterial substances produced by moulds and other micro-organisms.

The word 'biotics' could be used in a parallel sense to describe all substances of natural origin, and more particularly substances produced by micro-organisms, minute amounts of which are capable of stimulating the metabolism of living organisms and which are specific in their action, that is, not readily replaced even by closely related substances.

PROGRESS IN GEOGRAPHICAL METHOD

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UNTIL the close of the nineteenth century, all attempts to construct a system of geography or to provide the subject with a distinctive philosophy were virtually confined to Germany and France. Down to the time of Herbertson, who was at Oxford early this century, there was remarkably little attention to the subject in Great Britain, and the investigations of even the most distinguished Continental geographers failed to arouse more than meagre interest in these islands. The exclusion of geography from the universities of Great Britain, until two or three decades ago, merits the notice of our educationists to-day, not so much because the development of the subject is significant to them, but because the conditions which deprived geography of fair opportunities for growth in nineteenth-century England are, to a considerable extent, still operative. This article is, however, not concerned with the position of geography in British education, but with those trends, in both method and concept, which have marked the development of the subject abroad, and particularly in Germany, from the late eighteenth century onwards.

Wherever geography is studied to-day, the systems employed clearly show the influence of Alexander von Humboldt and his contemporary, Karl Ritter. They were the acknowledged masters, in their respective fields, during the first half of the nineteenth century—'the classical period of geography', as it is known. Markedly different in outlook, they were yet complementary to each other, though most of the concepts they introduced originated in the thoughts of earlier German and French writers. In the first half of the eighteenth century there was much interest in the possible influence of environmental factors on the evolution of society. In particular, the ideas of Montesquieu expressed in "De l'esprit des lois" (1748) made a deeper impression than German geographers have been prepared to acknowledge.

Before the 'classical period' the place of geography within the body of knowledge was assessed according to the view taken of its practical utility, and particularly of its service in contributing to a full understanding of history. Even before the opening of the nineteenth century, however, there were those who wished to raise geography from its position of subordination to other studies and to make of it an independent science. Already there was widespread dissatisfaction with the political divisions of Europe as units of geography. For the purposes of geographical analysis such divisions, it was thought, should be replaced by 'natural' entities, with frontiers fixed and enduring. Theorization along these lines led to the first serious attempt to provide a partition of the world into regions: it was the work of the German geographer, Gatterer, in the period 1773–75.

Not widely known is the attention paid by Immanuel Kant to geographical investigations. His lectures on 'physical geography' at the University of Königsberg continued for forty successive sessions (1756–96). In his view, the organization of phenomena by classes divided Nature, without providing a coherent system, whereas 'physical geography', as he understood it, introduced the concept of unity to the study of man's environment. Two contrasted methods of geographical inquiry were already employed in Kant's day. One was the study of particular classes of phenomena in their distribution over the earth; the other involved relationships and interactions of many kinds of phenomena in particular regions of the world. The terms 'general' or 'systematic', for the first, and 'regional' for the second, were already coming into use. This early-established dualism, which still persists, has probably brought more confusion to geography than any other development in the method of the subject. In his 'physical geography' Kant was not limited to the environment of man: he was concerned with man also, as one of those agents of change which acted upon and modified the earth's surface.

The publication of the Africa volume, together with one of two Asiatic volumes, of "Die Erdkunde"[1], in 1817 and 1818, respectively, brought Karl Ritter to the forefront of geographical scholarship. To him more than to any other, with the possible exception of his friend and compatriot, Humboldt, is due the establishment of geography as an independent science. Moreover, his geographical interests and knowledge were more extensive than those of any previous scholar, as was recognized by an invitation to the chair of geography at the University of Berlin, then the only appointment of its kind in Germany, and the second in Europe. In "Die Erdkunde", a massive work, where history and geography meet in fruitful association, his main objective was to comprehend the influence of geographical factors on the social and economic development of society.

Comparison between Ritter and Humboldt emphasizes the much greater range of the latter's first-hand observations of natural phenomena, obtained through expeditions to Asia and America. In outlook and method they had much in common, though Humboldt was more concerned with the environment of man than with man himself. In the first of the five volumes of "Kosmos", physical geography was defined as a study of phenomena, arranged in areas, in their relations to all other phenomena with which they form a natural whole. While the so-called natural sciences study the forms, structures and processes of animals, plants and other phenomena, and seek to group them in classes or families according to their analogies, geography concerns itself only with these same phenomena as they occur together, related to each other within an area. No modern student of the subject has been able to add materially to this central idea in Humboldt's definition.

Though without immediate disciples, Humboldt exerted a much wider influence than Ritter, whose academic position, however, gave full opportunity for contacts with students. Elisée Reclus (1830–1905), more than any other, maintained the traditions of Ritter, as was shown by his exhaustive study, in nineteen volumes, of the regions of the world[2]. He provided the model and inspiration for the greatest of modern enterprises in regional geography, namely, "Géographie universelle", contributed by the most distinguished geographers of France, under the leadership of Vidal de la Blache. Among others indebted to Ritter for geographical training was Field-Marshal Moltke, founder of the German Imperial Army and the leading strategist of his time. Moltke undertook a variety of geographical studies, before concentrating upon geography in its relation to strategy—a study which has always commanded the respect of the German General Staff.

In Germany and France, therefore, the range of geographical inquiry was clearly comprehended by the closing years of the nineteenth century. Moreover, specialization within the subject had already begun, its first essay being the study of land-forms. Peschel, whose work appeared from 1866 onwards, was an early experimentalist in this field, though he extended his interests to an interpretation of the influence of the surface features of the earth on human activities. From his day down to the present, geomorphology has been accepted in Germany as lying wholly within the province of the geographer, and the fundamental basis of all his investigations. Yet it is undeniable that in Germany, as also in Britain and America, the majority of the principal contributions to the study of land-forms have come from men of science whose original interest and discipline was geological, however brilliant their incidental excursions into geography might be. In geomorphology the geologist and the geographer meet in effective partnership, but their respective contributions are complementary, not interchangeable.

Teutonic zeal for the science of land-forms proved to be infectious abroad, more particularly in the United States, where, through the agency of W. M. Davis, interest in the evolution of landscape spread widely. In view of their long apprenticeship in physical geography, American geographers should be encouraged to co-operate in a regional synthesis of land-forms, for the world as a whole. Such an enterprise is urgently needed, in order to supplement and modernize the world survey, largely geological in purpose, of the elder Suess[3]. Much of Europe and North America, not to mention other continents, has been covered by detailed geomorphological studies, and the material for such a work has long been accumulating.

The interests of the humanistic school of German geographers were maintained during 'the geomorphological period', as witness the studies of Friedrich Ratzel in the field which, quite inappropriately, he named *Anthropogeographie*. Ratzel's concepts had a wider appeal in Britain than those of other German geographers, which was the more unfortunate in that his work did not attain a standard of scientific scholarship equal to that of either Ritter or Humboldt. He was fortunate, however, in inspiring his gifted student, E. C. Semple, to undertake editorship and translation, with an Anglo-Saxon audience in mind[4]. Despite the title of his work, Ratzel was not concerned with the geography of racial distribution. His special interest lay in the response of man to environmental possibilities, and his name will always be associated with the earliest studies in the geography of States, that is, political geography.

Sufficient evidence is thus forthcoming for the co-existence, by the close of the nineteenth century, of two contrasted schools of geographical thought, the physical and the humanistic, respectively. Divergence of outlook was already so serious as to occasion deep concern to those German geographers who were determined to preserve the unity of their subject. In this connexion the distinguished contribution of Alfred Hettner, the most consistent and active student of geographical method in Europe during the last half-century, is particularly important. His authority to speak on the legitimacy of recent trends in geography was virtually unchallenged just before the present War[5].

Hettner insisted, early this century, that for the geographer the map is the essential means of expression. In 1905, he claimed that the development of cartographic methods had advanced so far that verbal description in geography had lost its original importance, and was useful merely to assist in the explanation of maps. To Hettner and others of like mind the quality of a geographer's contribution depends largely on the effectiveness with which he employs his cartographical technique. As the American geographer, James, has it, that contribution depends upon an "application of the technique of mapping distributions, and of comparing and generalizing the patterns of distribution"[6].

Of all Hettner's contributions to the progress of geographical method the most significant is associated with the idea of the 'region'. Like others of his time—Passarge and Herbertson are notable examples—he constructed a regional system which he regarded as essential to the organization of the study of the earth as the home of man. More thoroughly, however, than any of his contemporaries, or predecessors, he has investigated the theoretical requirements for such a classification of regions, and his is the only system which, in both conception and practical use, endeavours to associate, not only one or two criteria—such as climate and vegetation—but all the major factors of environment which are significant to mankind. At the same time, Hettner does not fall into the error of regarding regional divisions as a part of terrestrial reality: for him their validity is always subject to challenge. As he readily admitted, the difficult question as to which criteria should be selected for the determination of regions finds no answer in Nature. The choice is made by "the geographer, according to his subjective judgment of their importance. There is no universally valid regional division which does justice to all phenomena: we can endeavour only to secure a division with the greatest possible number of advantages and the least possible disadvantages". Hettner's classification of regions was published for the first time in Spamer's Atlas of 1897: completed and revised, it appeared later in two volumes as "Grundzüge der Länderkunde".

Of all the problems in geographical method, that which turns on the validity of the criteria employed in regional classification has aroused the most vigorous discussion. Recently it has stimulated the younger school of geographers in Britain, though the criticisms brought forward, up to date, have been more important on their negative than on their constructive side. The chief difficulty in attaining a

regional classification acceptable to the strictest canons of geographical method, results from some remaining uncertainty as to the place of man within the frontiers of geography. It is an old problem, but attention to it is more persistent and active than ever before, and the geographical schools of North America deserve the respect of their European colleagues for outstanding contributions to its solution. In the United States, discussion of method in geography is now much more purposeful than elsewhere. There we see the growth to very productive maturity of several particularly competent philosophers of geography. As an analysis of doctrine Hartshorne's recent work—"The Nature of Geography" (1939)—is probably without precedent in the history of the subject.

For the future the prospects of geography in Britain seem particularly bright, and for two main reasons: first, the subject has now a trained personnel of university rank, out of all proportion to the meagre team which was working at the beginning of the century, when only one chair of geography existed in Britain; secondly, attention to geographical principles and perspective is now recognized as essential to the political and economic planning, which are so desperately needed by an exhausted world.

Events of the last thirty years have brought the realization that planning along exclusively national lines, outside an international system, is completely abortive. Although the practicability of regarding the world as the unit of political and economic reconstruction has not yet gained general acceptance, a continental area has already proved to be a unit which is administratively possible, as witness the United States and the U.S.S.R. Ideas concerning the organization of territory and its population, in the interests of mankind as a whole, belong to the normal stock-in-trade of the geographer. Whatever may be the mistakes with which he is charged, the geographer certainly cannot be accused of parochialism of outlook.

In the interests of the academic prestige of his subject, it would be opportune for the geographer to undertake highly specialized regional research corresponding to the detailed investigations, into the events of very restricted periods of time, which are usual to the specialist historian. The monographs on the regions of France, contributed by Vidal de la Blache and his distinguished school, provide the model for similar studies on the regions of Britain. (How often have we to deplore that there is not in existence a scholarly, and at the same time comprehensive, published study of the geography of our own country.) A similar policy is not to be recommended, however, for the teaching of geography, except towards the close of the university course, when specialization is not likely to disturb the student's perspective. On the other hand, no honours school of diminutive staff should so disperse its teaching resources as to provide instruction in every phase of the subject.

[1] "Die Erdkunde, im Verhältniss zur Natur und zur Geschichte des Menschen".

[2] "Nouvelle géographie universelle" (Paris, 1876–1894).

[3] "The Face of the Earth" (English edition, trans. Sollas), 5 vols. (1904–24).

[4] Semple, E. C., "Influences of Geographic Environment" (1911).

[5] Hettner's numerous papers, down to 1927, are collected in "Die Geographie, ihre Geschichte, ihr Wesen und ihre Methoden" (Breslau, 1927).

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A FISH-FARMING EXPERIMENT IN A SEA LOCH

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Introduction

IN 1941 it was suggested in NATURE[1] that it might be possible to increase our food supply by increasing the fertility of suitable parts of the sea, and a scheme for a preliminary investigation was outlined. It was based on the assumption that the fertility of the sea is largely dependent on the same factors as that of the land or of freshwater fish ponds, namely, light and plant nutrients, and that an improvement could be obtained by supplementing with artificial fertilizers the amount of nutrients available for plant growth. Of these, nitrate and phosphate are known to limit the growth of phytoplankton in the sea, and it was assumed that the addition of sodium nitrate and superphosphate would lead to: (1) a higher level of plankton productivity; (2) a greater density of bottom fauna; and (3) an increased growth-rate of fish. (After we had started our work we found that the effect of fertilizers on the first link in this chain had been tried out in oyster polls in Norway so early as 1908, but no results were published until the fertilization experiments of Gaarder and Spärck in 1932[2,3]. They found that the addition of dissolved phosphorus and nitrogen in 5–10 times normal winter sea values led to an increase in nano- and zoo-plankton and also to a good growth of oyster larvæ.)

An experiment on the lines suggested was made possible by a generous offer of financial assistance from Imperial Chemical Industries Ltd., Billingham, which has led to a very active and stimulating co-operation. Acknowledgment of much valuable help and encouragement received from many other quarters will be included in a full account of our experiment which we hope to publish in the near future.

Our investigations were started two years ago, and until July 1943 observations and collections of samples were possible only during visits over week-ends and university vacations. Since then Mr. S. R. Nutman and Mr. D. T. Gauld have joined our team, and have been responsible for the collection of a considerable proportion of our data and results.

Hydrography and Fertilization

The site chosen for the experiment was Loch Craiglin, a small arm of Loch Sween, Argyll, covering an area of about eighteen acres, and connected with the large northern arm of the loch (Sailean More) by a narrow channel. A dam with a sluice was built across the channel; but as the dam was by no means watertight a considerable amount of water exchange took place between Loch Craiglin and Sailean More, particularly at high tides. The volume of the loch is some 70,000 cubic metres; its maximum depth about 5 metres, with an average depth of 1–2 metres.

The hydrographic conditions resemble closely those of the Norwegian oyster polls, which show much greater variations than the open sea. The salinity in deep water varied from 29 to 30 per thousand, which

is only a little below that of the open loch, while at and near the surface there was water of low salinity (9–28 per thousand). The temperature during most of the year was well above that of the open loch (maximum 22° C.).

During summer the abundant growth of green algæ (Cladophora and Enteromorpha) caused oxygen supersaturation and pH values of 9 and more, except in deep water where free hydrogen sulphide was present during the autumn and winter and where pH values of 7 and less were recorded. The water varied from brown to green in colour owing to suspended and dissolved matter, and at times more than 90 per cent of the incident light was absorbed by the upper $\frac{1}{4}$ m. layer.

Fertilizers were distributed in Loch Craiglin on ten different dates during the first year, beginning in April 1942. Altogether some 600 lb. sodium nitrate and 400 lb. superphosphate have been added, equivalent to 45 kgm. nitrogen and 17 kgm. phosphorus, that is, about five times and ten times their respective maximum winter values in the Clyde sea area. In the second year the amount of sodium nitrate was doubled at each fertilization, and by the beginning of this year another 600 lb. of nitrate and 200 lb. of phosphate have been added.

Utilization of the added fertilizers in the well illuminated layers was extremely rapid. On several occasions when fertilizers were distributed, only traces could be found in deeper water a week later. Day-to-day observations by Mr. Gauld showed that even when the values were increased to about four times maximum winter sea value, the dissolved phosphorus was completely removed in about four days.

Plankton

The most marked effect of the added fertilizers was on the so-called μ-flagellates, a much neglected group of autotrophic organisms, about 1–10 μ in size, which undoubtedly play an important part in the economy of the sea, by providing the bulk of the food for larval forms of copepods, lamellibranchs, etc., and part of the food of adult 'filterfeeders'[4,5,6,7].

Thus on December 30, 1942, one day after fertilization, the average number of μ-flagellates was 1,600 per cub. mm.; three days later it had risen to 3,900, five days later it was 3,100. On January 31, the highest population density for the year with more than 8,000 per cub. mm. was reached, as compared with the maximum density of 2,000 for Sailean More. Since the rise in μ-flagellates ran parallel to the depletion of nutrients, it appears that at least a large fraction of the dissolved fertilizers was rapidly taken up by, and converted into, μ-flagellates.

Fertilization had a less immediate effect on the diatoms and dinoflagellates. The spring diatom increase began in the middle of February, just after the deeper water in Loch Craiglin became stabilized, and lasted for several weeks. Diatoms were scarce during the summer but reappeared when the loch was fertilized again in September, and rose to high figures after the November fertilization. Minute species of Chaetoceros were responsible for both spring and autumn increases, when the maximum numbers averaged more than 7,000 cells per ml. from surface to 3 metres.

The most marked characteristic of the larger phytoplankton was the abundance of small thecate photosynthetic dinoflagellates, chiefly *Prorocentrum micans* and *Peridinium triquetra*. They were present throughout the year and the second rose to extraordinarily high numbers during the autumn and winter, reaching a figure of 1,600 per ml. in December.

In spring, fertilization had no apparent effect on any of the phytoplankton organisms, partly owing to the abstraction of nutrients by the actively growing shore algæ (Enteromorpha and Cladophora) and partly because of the grazing of a very large zooplankton population.

The zooplankton was characterized by a rich period early in the year, from March until May, and a rather poor period from summer until the end of the year. Copepods, of which Oithona and Acartia were the most abundant forms, rotifers and lamellibranch larvæ made up the bulk of the zooplankton.

When compared with the unfertilized water of the open loch (Sailean More) the plankton was found to differ in several ways and was almost always considerably richer. On the whole, Loch Craiglin, under the conditions of fertilization, ranks among the richest plankton areas known.

Bottom Fauna and the Food of Flatfish

The density of the bottom fauna showed great variations in different areas even before fertilization began. An extremely poor zone in the deeper region occupied about a quarter of the total area of Craiglin, while along the shallow eastern shore and southern bay a dense population flourished. The commonest animals were Chironomid larvæ, Hydrobia, Cardium, Oligochætes, Gammarus, Idothea, Nemertines and Capitellids, Chironomids being predominant.

If the populations at five sampling stations (two of which lie in the very poor zone) are averaged, we find that over the bottom of the whole loch the post-fertilization summer density had increased by 150 per cent over the winter pre-fertilization value. This increase might be regarded as an effect purely of summer reproduction, but the density of the bottom fauna would have been much greater but for the introduction of more than 3,000 flatfish, which, in addition to a large population of native small fishes (gobies, sticklebacks, etc.), greatly reduced the bottom population.

In the following winter (1942), the bottom fauna declined sharply owing, presumably, to the cessation of reproduction and to the continued feeding of the fish. Yet by the following summer (August 1943), despite the additional grazing depredations caused by a further stocking with 22,000 flounders and by the greatly increased numbers of small native fish, the average density of bottom fauna had increased by 240 per cent over the previous post-fertilization summer value. Furthermore, this great population only showed a slight decline during the autumn, and thus, in contrast to 1942, a great 'standing crop' of bottom fauna was maintained.

Some animals (Crustacea and Cardium), which showed no rise in population during the first summer, showed a spectacular increase in 1943.

An approximate calculation for the dry organic weight of the bottom fauna indicated that the fauna 'useful' as food for flatfish showed an increase in weight by August 1943 of 215 per cent over the previous summer value.

An analysis of the macroscopic organisms present in the alimentary canals of flatfish caught in Loch Craiglin showed that while plaice fed almost exclusively on Cardium, Hydrobia and polychætes, flounders were more general feeders. Flounders showed an average of 190 organisms per gut during winter. This intensive feeding was correlated with

good winter growth. The average weight and number of animals consumed increased during spring, reaching a maximum of 1,520 organisms per gut in June, when Chironomid larvæ formed almost 100 per cent of the food. A decline in feeding occurred during summer, although there was an abundance of food, and at the same time young Cardium became progressively more important in the diet, making up 70 per cent of the total food by October.

Growth of Plaice and Flounders

Between April and July 1942 some 2,700 small flounders and 600 plaice were transplanted to Loch Craiglin; of these, 425 plaice, 9–29 cm., were marked with numbered disks. The remaining 175 of a size less than 9 cm. were left unmarked. Fishing in Loch Craiglin presented great technical difficulties, caused by the nature of the bottom, and the number of recaptured fish during the first year, that is, by April 1943, was relatively small, namely, 57 (13·4 per cent) marked plaice, 32 (18·3 per cent) unmarked plaice, and 108 (4 per cent) unmarked flounders. In addition 11 flounders, varying from 20 to 30 cm., were caught, obviously 'native' fish which had been in the loch when it was dammed off.

The great majority of the marked plaice recaptured had their disks torn out. On the whole they have grown well in Loch Craiglin but not strikingly better than under natural conditions, the main reason being the profound setback received from marking.

The majority of unmarked plaice belonged to age-group I, that is, they were a little more than a year old when transplanted. The average length of the lot put in was 7·5 cm., the average weight 4·5 gm. In July 1943 their length was 22 cm., weight 117 gm. This represents an increase in length of 14·5 cm. or nearly 200 per cent and an increase in weight of 112 gm. or twenty-five times their original weight in about one year and one month.

In the North Sea the annual growth increment of plaice varies between 3 and 6 cm.[8,9,10]. The unmarked plaice in Loch Craiglin have thus accomplished 2–3 years' growth in a little more than a year. They were closely approaching the growth-rate of plaice transplanted to the Dogger Bank[11] and Limfjord[12], that is, areas characterized by an exceptional abundance of food animals and a sparse fish population.

Flounders transplanted in July 1942 from Loch Killisport had an average length of 3·4 cm. and 0·5 gm. weight. The same year-class in Loch Killisport reached a size of 5·1 cm. and 1·5 gm. in September and added only very little to their size by next April. At this time the flounders in Loch Craiglin had reached an average length of 11·8 cm. and a weight of more than 20 gm. During the first year they have grown about four times as fast in length and sixteen times as rapidly in weight as the Loch Killisport flounders.

During April–May 1943 we transplanted more than 1,000 one-year old flounders, and in July more than 21,000 flounders of 0-Group into Loch Craiglin. Although the fish were preyed upon by eels and cormorants, the new stocks increased the fish population, at least temporarily, to 1,000 fish per acre.

In spite of the much greater competition for food, our original flounder stock continued to grow very rapidly and reached an average size of 25·0 cm.–197 gm. by October 1943.

The annual growth increments of flounders growing under natural conditions in the Baltic—and what figures are available concerning their growth in Scottish waters are of the same order of magnitude—are about 5 cm. to begin with, declining to about 3 cm. in the fifth and sixth year[13,14,15]. The flounders in Loch Craiglin have thus completed a growth of 5–6 years in less than two years. The growth of the flounder stocks transplanted in 1943 has so far been equally satisfactory.

Both plaice and flounders, marked and unmarked, showed a remarkable growth during winter, amounting to a weight increase of 35–97 per cent during the period November 1942–April 1943. Thus the cessation of growth of fish on normal grounds during winter seems to be largely due to scarcity of fish food and not so much to climatic factors.

Conclusions

Our assumptions regarding the beneficial effect of fertilizers, through a complex food chain, on fish growth have proved correct. Moreover, the extremely rapid utilization of the fertilizers has opened up new possibilities: marine fish farming need not, perhaps, be confined to dammed off or very sheltered parts of the sea as we thought two years ago.

Our results strongly suggest that the excessively low productivity of the sea as compared with the land and as expressed in the low rate of both survival and growth of fish, is ultimately due to the scarcity of plant nutrients, that is, of nitrogen and phosphorus. Application of fertilizers, combined with hatching operations, might become a practical means of improving the yield of inshore fisheries, and lead to a future when fisheries will follow the path of agriculture; when development and production will take the place of conservation and restriction.

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CENTRIFUGAL VACUUM FREEZING

ITS APPLICATION TO THE DRYING OF BIOLOGICAL MATERIALS FROM THE FROZEN STATE

By R. I. N. GREAVES

Drying Unit, Medical Research Council

MANY biological materials can be most conveniently preserved in one way only, namely, if they are dried from the frozen state. The success of the 'freeze-drying' procedure appears to be chiefly related to the fact that the resulting 'solid state' prevents the concentration and aggregation of the molecules of protein which, when they are dried from the liquid state, leads to their denaturation. The temperature of drying is of little importance provided it is below the eutectic point of the material and so

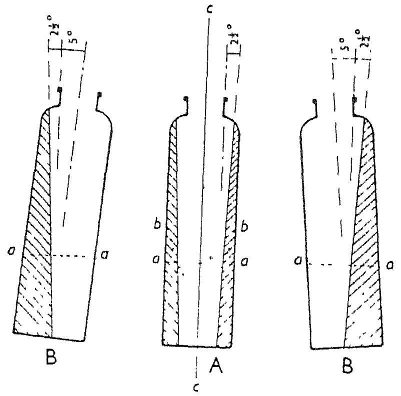
causes the solid state to be maintained throughout the period of desiccation. Moreover, on slow freezing, concentration of proteins and salts takes place. Therefore, to get the best dried product, particular attention must be paid to the freezing of the solutions.

In order that drying may be accomplished in a reasonable period of time, it is necessary to carry out the process in a high vacuum with adequate provision for the removal of the water vapour evolved. Under these conditions evaporation can be made so rapid that a liquid will freeze and the frozen material will drop in temperature unless the heat lost by evaporation is replaced. The speed of drying depends on the rapidity with which the heat lost can be replaced without causing the fusion of the frozen material.

When a protein solution is subjected to a high vacuum, it froths and bubbles violently before freezing with extreme suddenness. Although such a rapid freeze gives an ideal dried product, the method has grave limitations owing to the excessively large size of the container which must be used if the material is to be prevented from escaping. Hartley[1] has shown that this frothing is largely due to the liberation of the dissolved gases under reduced pressure, and that quiescent fluids can be obtained if these dissolved gases are first removed by a carefully controlled slow reduction of pressure. Greaves and Adair[2] and Flosdorf and Mudd[3] made use of this method of 'degassing' for obtaining quiescent solutions which could then be 'snap-frozen' and dried from the frozen state, if the pressure was suddenly reduced below the critical level. This method has been widely used, but it has certain disadvantages; for example, small quantities tend to dry from the liquid state during 'degassing', freezing tends to be somewhat erratic and unless the 'degassing' has been very thoroughly carried out some of the material may explode on freezing and be lost.

The alternative is to pre-freeze the material and introduce it frozen into the vacuum. Pre-freezing must be rapid in order to avoid concentration and obtain a good dried product; this procedure involves either low-temperature baths of 'dry-ice' or the vertical spin-freeze technique of Greaves[4], which is carried out in a current of cold air at $-18°$ C. Pre-freezing is convenient when drying large amounts of material distributed in big individual doses. With small doses there is a danger that partial fusion may occur before the necessary degree of vacuum is attained unless provision, with the resulting complications of manifolds or refrigerated heater heads, is made for keeping the ampoules refrigerated during this period. Consequently although since the outbreak of war great advances have been made in the large-scale drying of transfusion fluids in large individual doses, there has been little attention paid to the drying of large numbers of small doses, or to the small-scale drying of material which from time to time the laboratory worker may wish to preserve.

If frothing could be absolutely controlled, then the vacuum snap-freeze would be the method of choice for the drying of small doses. The previous endeavours to solve this problem have been along the lines of controlling the bubbles after their formation. From a physical point of view, however, a bubble is most vulnerable at its birth, and it occurred to me that some quite small force working against bubble formation might be sufficient to inhibit entirely its formation. For this reason the possibilities of centrifugation were investigated and it was found that quite slow speed, for example, 1,450 rev./min. with a



A. Bottle spinning on its vertical axis; liquid distributed round the periphery.
BB. Bottles spinning "off centre" inclined at an angle of 5° from the vertical; liquid distributed as a wedge on one side of the bottle.
aa. Original level of the liquid.
bb. Early stage in formation of cone as liquid gathers speed.
cc. Axis of rotation.

The angle of the final liquid surface from the vertical depends on the speed, and is approximate only.

minimal radius of 1 inch was more than adequate to inhibit the formation of bubbles in liquids *in vacuo*, although under these conditions existing bubbles were not destroyed. Various protein solutions have been subjected to high vacuums while spinning and all have 'snap-frozen' most uniformly without the slightest trace of bubble formation.

The centrifugal force has another use in that if the ampoule or bottle is spun on its vertical axis a cone is forced down through the liquid, thus distributing it round the inside periphery of the bottle, in which position it freezes and thus exposes a maximum surface for evaporation during the drying process (Greaves[4]). Obviously, the mechanics for accomplishing this condition for large numbers of ampoules would be difficult, but since quantities of 10 ml. or less if frozen as a wedge on one side of the ampoule would expose quite an adequate surface for drying, this condition can be accomplished much more simply by spinning the ampoules off centre and inclined at an angle of 5° from the vertical (see diagram). Thus in an apparatus of the type described by Greaves and Adair[5], several large disks drilled out to accommodate numerous ampoules can be spun on a common central shaft, the heat required for drying being transmitted by radiation from a heater-winding wound on a reflector screen below each disk.

This method has been applied extremely satisfactorily to the drying of sera and plasma, and is particularly suitable for the drying of 'complement'. Broths and crude penicillin solutions, which frequently prove difficult to dry by other methods, since they possess fractions which remain liquid at low temperatures, have been successfully handled by keeping the centrifuge running until the temperature of the material was low enough for this second component to be frozen. The method has also worked well even with very small quantities, for example, quantities so small as 1/40 ml. have been dried successfully from the frozen state; but with these very small quantities it is necessary to attain the requisite vacuum rapidly or there will be a tendency for them to dry out from the liquid state. For small quantities, phosphorus pentoxide has been used as a desiccant,

and for large amounts a mechanically refrigerated condenser.

Presumably the principle of preventing frothing by centrifugation could be applied also to many types of vacuum distillation in which frothing and bumping prove troublesome.

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OBITUARIES

Sir Cecil Harcourt-Smith, K.C.V.O.

CECIL HARCOURT-SMITH was born on September 11, 1859, and died on March 27, 1944. In a long career he combined the tastes and studies of a classical scholar, an archæologist, and a connoisseur of medieval and Oriental art, with great ability as a Civil servant and administrator. His father, William Smith, was a solicitor. From a school at Brighton he was elected a scholar of Winchester College in 1873, but instead of passing on to university life, he entered the British Museum in 1879, in the Department of Greek and Roman Antiquities. His tastes were indeed already formed, and gained opportunities for advanced study on a broad programme, which would in those days have been difficult to achieve at college. His school contemporary, Arthur Hamilton Smith, who was his successor as keeper of his Department in the Museum, only arrived there seven years later, by way of a Cambridge degree and a fellowship.

For a while Smith's work was mainly in classical archæology. He was an active member of the Hellenic Society and of the Classical Association, and one of the founders and first editors of the *Classical Review*, which profited greatly by his wide interest in antiquities. But in 1887 he was attached to a diplomatic mission to Persia, and made ample use of this chance of studying a great tradition of Oriental art in its own surroundings. A second exceptional opportunity for field studies came in 1896, when the British School of Archæology at Athens was recognized by a Treasury grant, and it was thought wise to give it temporarily the experience of a Civil servant as director. This position he held for two sessions with great benefit to the School. Two fresh adventures were successfully launched, the *Annual*, a substantial budget of contributions to knowledge by the senior students and former students, and the memorable excavation of the prehistoric town at Phylakopi in Melos, the first inhabited site in Greek lands to be so revealed since Schliemann's work at Hissarlik, Mycenæ, and Tiryns. It was not Smith's fault that publication was delayed until 1904, by which time its significance was eclipsed by far larger achievements at Knossos. But Phylakopi has its distinguished place in the perspective of Aryan archæology, and in the British contribution to it.

During these years, Smith was promoted assistant keeper in the Museum, and became keeper in 1904. His principal publication there was the volume of the great "Catalogue of Greek Vases", dealing with the earlier Greek styles ; his preliminary work on the prehistoric pottery was interrupted by the Museum's own excavations in Cyprus, which brought in a very large contribution to the Late Minoan section, as well as to the pre-Minoan and Early Iron Age series.

Meanwhile, Smith had been extending his experience of archæological administration both at home and abroad, and in 1908 he was appointed chairman of the Commission to consider rearrangement of the Victoria and Albert Museum, which had completely outgrown both its accommodation and its original function as an appendage of the old Science and Art Department ; and its relations with the British Museum had never been satisfactorily defined. Here Smith's knowledge, tact and initiative created a new order, and it was an obvious sequel that he should be the new director and secretary, to give effect to his Committee's proposals. From 1909 until 1924, the Victoria and Albert Museum prospered under his guidance. Valuable objects were secured, such as the Salting collection, the Rodin sculptures (later transferred to the Tate Gallery), the Alma Tadema library, and the Pierpont Morgan stained glass. A great series of catalogues was prepared by an enlarged, better trained, and better paid staff ; space was provided for students throughout the Museum, and especially in the library ; official guides and reproductions were organized, and special exhibitions arranged from time to time.

With so many interests, and personal gifts, Smith led a busy life, and recognition came in due course : knighthood in 1909, C.V.O. in 1917, and K.C.V.O. in 1934. After retiring from the Museum, Sir Cecil became adviser in 1925 for the Royal Art Collections, and in 1928 surveyor of the Royal Works of Art. His medieval interests made him a leading member of the Central Committee for the Care of Churches, and the Incorporated Church Building Society. The Franco-British Exhibition of 1921 was in great measure his work. He was secretary of the Society of Dilettanti and brought out its "History" in 1932, and a constant friend and counsellor of collectors and colleagues at home and abroad. His personal charm, eloquence and skill in languages made him a valued member of committees and congresses of many kinds ; and in these social activities his accomplished wife gave him unfailing support. Grateful acknowledgment must be made of his constant and sympathetic encouragement of younger people. Few men had their knowledge available so promptly or so generously.

JOHN L. MYRES.

Dr. A. W. Pollard, C.B., F.B.A.

ALFRED WILLIAM POLLARD, who died on March 8, aged eighty-six, had lived for some years in retirement, but bibliographers and students of literature will find it hard to believe that he is dead, so vivid was his mind and so fertile his work.

The son of a London medical man, Pollard was educated at King's College School, then still in the Strand, and at St. John's College, Oxford, where he was placed in the first class in Mods. and, unlike his friend and fellow-scholar Housman, also in Greats. In 1883 he was appointed an assistant in the British Museum Library, some other possible professions being barred by a bad stammer, and thus the nature of his life-work was determined.

An early marriage made extra work necessary, and the material was at his hand in the Museum. He helped Dr. Furnivall with the Early English Text Society's transcripts of Chaucer manuscripts, reviewed for the *Guardian* in its great days under D. C. Lathbury, edited Herrick and a collection of "English Miracle Plays", while his work on Chaucer bore

fruit rather later in the Globe edition of the "Works" and a "Primer".

In the Herrick, a taste for fine (not necessarily luxurious) book production was already visible, and in the Museum Pollard was already becoming recognized as the Library's expert on typography. In the same year (1893) this side of his activity was given fresh impetus by two events. Robert Proctor joined the Library's staff; in the next ten years Proctor was to put the history of the first fifty years of printing on a new basis, and Pollard learned much from working with his younger colleague, whose work he completed by founding the Museum's great catalogue of incunabula. He became honorary secretary of the newly founded Bibliographical Society, a post he was to hold until 1934, ten years after his retirement from the keepership of printed books in the Museum. For those forty years Pollard directed the Society, and with the help of Proctor, R. B. McKerrow, Dr. W. W. Greg and other scholars used it to produce a large body of valuable contributions to the bibliography and history of literature, particularly English literature of the fifteenth, sixteenth and seventeenth centuries.

Another special study of his was the English Bible, of which he published a volume of "Records" in 1911, the fruit of the Museum's exhibition at the tercentenary of the Authorized Version. But he is best known, perhaps, by his application of bibliography to the text of Shakespeare. He published his "Shakespeare's Folios and Quartos" so early as 1909, and followed it up with other publications, culminating in his British Academy Lecture, "The Foundations of Shakespeare's Text", in 1923, suggesting a new and fruitful method, which has been well used by Prof. J. D. Wilson and others.

In 1887 Pollard married Miss Alice England, of Newnham College, who predeceased him. They had two sons, both of whom were killed in the War of 1914–18, and a daughter, who survives him. Those who knew him at the time of his great loss found his noble bearing an inspiration; it deepened the affection and respect in which he had always been regarded in and outside the Museum for his great talents, his industry, his warm heart and his lofty and religious nature. ARUNDELL ESDAILE.

Prof. A. E. Jolliffe

ARTHUR ERNEST JOLLIFFE, who retired from the professorship of mathematics in the University of London (King's College) in 1936, died in Oxford on March 17, 1944. He was educated at Balliol College, Oxford, won the Junior and Senior University Mathematical Scholarships and, shortly after taking his degree, was elected to a fellowship at Corpus Christi College, Oxford, in 1892. After a year at Lampeter as lecturer, he returned to Oxford as mathematical tutor at Corpus, a post which he held until 1920. He was then appointed professor of mathematics at Royal Holloway College, from which he proceeded to the professorship at King's in 1924.

Jolliffe was one of the outstanding mathematical tutors of his time. On his return to Oxford in 1893, he at once devoted himself wholeheartedly and with complete selflessness to the interests of his pupils. Privileged indeed were the Corpus scholars of his early days, for whom his time was measured not in hours but solely by their capacity to profit by his instruction. His solutions of problems in all branches of mathematics and his methods of exposition were brilliant, and bore full evidence of his powers of clear thinking and of his great originality of mind, and gave hope that he would devote some part of his time to research. But his teaching became an all-absorbing interest, with the result that he published relatively little. He was at his best when talking to two or three pupils at a time in Oxford, and was never quite so happy in London, where it fell to his lot to teach large classes of students. He was quite ruthless with the student who was self-satisfied or uninterested, but spared no pains in helping even the unintelligent, provided he showed a genuine desire for information. He was an excellent head of a mathematical department, inspiring his staff with his keenness, for he took it for granted that all were as conscientious and hard-working as himself. As chairman of a board of examiners he was a tower of strength, and his papers always provided a searching test of the ability of the candidates rather than an opportunity to reproduce a complicated piece of reasoning imperfectly understood.

Jolliffe did not enjoy the leisure of retirement for long, for he was soon recalled to Oxford to help in an emergency in the work of Jesus College, and actually continued in that work until shortly before his death. S. T. SHOVELTON.

Dr. Alexander G. McAdie

WE regret to announce the death, on November 1, 1943, of Dr. Alexander G. McAdie at the age of eighty years. From 1903 until 1913 he was professor of meteorology in the United States Weather Bureau. In 1913 he became Rotch professor and director of the Blue Hill Meteorological Observatory, which post he held until 1931, when he became professor emeritus. In addition to his contributions to the science of meteorology, he was keenly interested in seismology. In spite of the loss by fire of valuable records in the 1906 California earthquake (while Dr. McAdie was working in San Francisco) he prepared, under the auspices of the Smithsonian Institution, a catalogue of earthquakes on the Pacific coast (1897–1906) which has recently been incorporated in a complete catalogue. In the summer of 1906 he called a meeting in San Francisco which led to the formation of the Seismological Society of America. He was its president during 1910–13, and of the Eastern Section during 1929–30.

WE regret to announce the following deaths:

Mr. J. W. Bullerwell, lecturer in physics from 1902 until 1938 at King's (formerly Armstrong) College, Newcastle upon Tyne, and secretary of the University of Durham Schools Examination Board during 1932–42, on March 17, aged seventy.

Dr. Charles B. Davenport, member of the U.S. National Academy of Sciences, the distinguished geneticist who was associated for many years with the Cold Spring Harbor Station of the Carnegie Institution of Washington, on February 18, aged seventy-seven.

Dr. E. C. S. Dickson, senior lecturer in physics in the University of Manchester, on April 8.

Mr. L. V. Lester-Garland, principal of Victoria College, Jersey, during 1896–1911, author of a "Flora of Jersey", on March 23, aged eighty-three.

Mr. E. C. Stuart Baker, C.I.E., O.B.E., a leading authority on Indian ornithology, on April 16, aged seventy-nine.

NEWS and VIEWS

Principalship of the University of Edinburgh: Sir Thomas H. Holland, K.C.S.I., K.C.I.E., F.R.S.

Sir Thomas Holland is retiring from the posts of principal and vice-chancellor of the University of Edinburgh at the end of the present session. In 1929 he succeeded Sir Alfred Ewing at Edinburgh, and the energy which he had shown during the seven years of his rectorship of the Imperial College of Science and Technology in London, and earlier in his war work in India and as director of the Geological Survey there, promised an era of vigorous development in Edinburgh. That promise has been amply fulfilled. He has been instrumental in instituting new degrees (B.Sc. and D.Sc.) in technical chemistry and in mining, and he has negotiated the passing of ordinances by the Privy Council modifying for the better the regulations for degrees in music, forestry, pure science and law. Under his care the teaching power of the University has expanded: nine new chairs have been founded—two in the Faculty of Arts, namely, psychology and geography, five in the Faculty of Divinity, the Edward Clark chair of child life and health in the Faculty of Medicine, and the Reid chair in the Faculty of Music. Although rumours have occasionally been heard of an alleged predilection for scientific interests, it is remarkable that the Faculty of Science is the only one (except law) in which there has been no new foundation during his tenure. Doubtless this apparent omission will be made good in the near future.

The professorial staff of the University of Edinburgh, therefore, increased during the past fifteen years from sixty-one to seventy, and in spite of the fact that about six chairs are vacant owing to war difficulties, this relatively short period has seen a great turn-over in the professoriate, Sir Thomas Holland having installed the present occupants of no fewer than thirty-six chairs. In other ways he has contributed to the development of Edinburgh as an educational centre, notably by the affiliation to the University, in 1933 and 1934, of two important teaching institutions, the Heriot-Watt College and the Royal (Dick) Veterinary College. The teaching and research staff (which has been augmented also by twenty new lectureships) is the most vital part of an educational institution; but buildings are also important, and here, too, great advances have been made. New independent blocks for the Departments of Engineering and Geology and the Institute of Animal Genetics have been erected in the King's Buildings area, which has become a considerable colony of the Faculty of Science, and there a much-appreciated social experiment has been successfully launched in the erection of a Common Room, with refectory, gymnasium, squash and tennis courts, all run by a committee of the students themselves. The creation of a much-needed extension of the medical buildings, already planned, has been unfortunately held up because of the War. It may interest readers, accustomed to standard gibes at the 'close fist' of the Scot, to learn that during Sir Thomas Holland's principalship, private individuals contributed, before the War, more than £500,000 to further the University's aims, and that even during the war years £180,000 has been given by former graduates and friends of the University.

Sir John Fraser, Bart., K.C.V.O.

Sir Thomas Holland will be succeeded in the principalship of the University of Edinburgh by Sir John Fraser, Bart. In Edinburgh the election of the principal is in the hands of the Curators of Patronage, a body consisting of three nominees of the University Court and four nominees of the Town Council of Edinburgh, a reminder of the fact that the "College of Edinburgh" was founded, in 1583, by the Town Council. The Curators' choice of Sir John Fraser will give general satisfaction. He is a medical graduate of Edinburgh, and studied as well in the Universities of Paris and Freiburg; since 1925 he has been regius professor of clinical surgery in the University and will be the first member of the staff to serve as principal since the days of Sir William Turner, who was transferred from the chair of anatomy in 1903. Sir John Fraser has gained fame as a brilliant surgeon, but he has also shown talent as an administrator, and is recognized as a man of generous outlook and keen social sympathies. In the difficult days which lie before the universities, Edinburgh is assured of steady and enlightened guidance, and of a wise balance of effort which will make for progress in all the activities, educational and social, of a great University.

Chair of Geography at Manchester: Prof. H. J. Fleure, F.R.S.

In September Prof. H. J. Fleure will retire from the chair of geography in the University of Manchester. He has held it since 1930, when he vacated the chair of geography and anthropology in the University College of Wales, Aberystwyth. During his tenure of the Manchester chair, Prof. Fleure has built up one of the strongest university schools of geography in Great Britain, and has increased the debt of which all who realize the significance of his subject in higher education were already conscious. He has combined to a remarkable degree unceasing efforts to raise the standard of geographical teaching in every branch of education with the continuous prosecution of active research. As honorary secretary of the Geographical Association and editor of *Geography* for twenty-five years, he has inspired many generations of teachers and greatly increased the facilities for the development of their subject in the schools. At the same time, his wide range of erudition, ripe scholarship and fertility of ideas, as exemplified in the illuminating series called "The Corridors of Time", which he wrote in collaboration with Mr. H. J. E. Peake, have earned him a high place in the field of investigation, which was fittingly recognized a few years ago by his election to the fellowship of the Royal Society. No scholar in Great Britain has done more to justify the claims of human geography, closely linked with both the natural sciences and the humanities but pursuing its own distinct objectives and devising its own technique and methods, to be one of the most illuminating approaches to the study of civilization and its problems.

Mr. Walter Fitzgerald

Mr. Walter Fitzgerald, who succeeds Prof. Fleure in the chair at Manchester, is a graduate of the University of Liverpool. His first appointment was as a lecturer in geography in the Transvaal University College at Pretoria. He returned to

England to become an assistant to the late Mr. W. H. Barker, then reader in geography at Manchester. After the latter's death in 1929, Mr. Fitzgerald was acting head of the Department during the interregnum, and soon after the election of Prof. Fleure to the newly created chair became senior lecturer in geography and has retained that position to the present time. Mr. Fitzgerald has travelled widely and is the author of a standard work on the regional geography of Africa. His views on some fundamental concepts of modern geography have been set forth in a series of three articles in NATURE, the last of which appears in this issue.

State Scientific Research in Great Britain

A STATEMENT of the existing Government organization has now been issued as a White Paper under the title "Scientific Research and Development" (Cmd. 6514. London: H.M. Stationery Office. 2*d*. net), to provide a factual background for the discussion of the part which the Government can play in this field after the War. After describing briefly the constitution and functions of the Development Commission and of the three Committees of the Privy Council for Scientific and Industrial Research, for Medical Research and for Agricultural Research, and the organizations working under them, the statement outlines the existing organization in each of those Government Departments which is faced with special scientific problems peculiar to its own field of activities and administers research and development organizations of its own or has scientific advisers on its staff. A further section of the White Paper describes the provision made by the Government for financial assistance to the universities for fundamental research, and the final section, on co-ordination and control organization, deals with the Scientific Advisory Committee of the War Cabinet and with the responsibilities of the Lord President of the Council in relation to scientific research. Although the statement includes no account of the special war-time activities of the research councils or of the research and development organizations of the Service and Supply Departments (including, for this purpose, the Ministry of Home Security) or of the many establishments working under their direction, it provides a very convenient picture of the structure of the Government organization for research in handy reference form.

Rail and Road Transport in Britain

THE third report from the Select Committee on National Expenditure for the session 1943–44, dealing with rail and road transport in Great Britain, well emphasizes the vital importance of transport in the war effort. The present agreement between the Government and the railway companies, which became operative on January 1, 1941, has given the Government a direct interest in costs of railway operation, and the report notes that receipts have increased, in round figures, by £95,500,000, while expenses have risen by £48,250,000 a year between 1940 and 1942. A close watch over railway operating expenditure is clearly essential from the point of view of national economy. On particular points, the Committee is disturbed at the congestion on the railways, in spite of the relief which the transfer of some traffic to the roads has brought. The congestion has aggravated an already serious coal situation, because filled wagons at colliery sidings have often not been movable, and the first recommendation is that the call-up of railway workers should cease, and that a steady influx of labour should be directed to the railways. Zoning has effected appreciable economies in railway transport. As regards passenger traffic, the Committee recommends that immediate consideration be given to the formulation of plans for the compulsory staggering of holidays. With regard to road transport, it is recommended that the Ministry of War Transport should immediately and closely re-examine the present freight charges and adjust them where necessary. The report also considers the Road Haulage Organisation, and the criticism of the scheme from the industry and the Ministry's reply. There is much evidence of extravagant use of vehicles and capacity, and the report finally recommends that a close scrutiny be made of the work of divisional and area haulage officers, and more particularly that of unit controllers, with the view of more economical use being made of lorries and their carrying capacity.

British Union Catalogue of Periodicals

AT the Association of Special Libraries and Information Bureaux Conference held in November 1942, following a paper presented by Mr. Theodore Besterman "On a Proposed Union Catalogue of Periodicals", the Association was requested to consider the possibility of publishing a union catalogue of British and foreign periodical publications on all subjects and of all dates, the location of which is traced in a library in the British Isles. A committee under the chairmanship of Dr. Luxmoore Newcombe, librarian of the National Central Library, and including members of the Library Association, the British Museum staff, the Joint Standing Committee on Library Co-operation and the Science Museum Library, satisfied itself that the project was practicable, and that the resulting Catalogue would prove an invaluable bibliographical tool. It was estimated that the compilation of the preliminary check-list, prepared from existing union and other lists and catalogues, would take about five years and that this check-list, in itself, would be of the utmost value. Moreover, it was clear that the planning of post-war rehabilitation of British library services must be based on an assessment of their present holdings, and for this alone the check-list would provide most useful help.

The project was submitted to the trustees of the Rockefeller Foundation, who have agreed to appropriate, for a period of five years beginning February 1, 1944, up to £14,000 to the Association of Special Libraries and Information Bureaux for the British Union Catalogue of Periodicals. Although the work will remain under the financial and general direction of the Association, the actual operative control of the production of the Catalogue will be in the hands of an executive council representative of the leading British library and bibliographical interests. The first meeting of this Council was held on March 28, when Mr. Theodore Besterman was appointed editor. Work on the compilation of the check-list will begin at once.

Australian Forestry in War-time

WITH the Dominion of Australia in the 'front line' and the necessity to conserve shipping space, timber has proved more important to Australia in this War than in that of 1914–18 (*Australian Forestry*, 7; 1943. Pilpel and Co., Perth, Western Australia). When a country's industrial effort expands, its timber demands expand also, as already exemplified in the

article "The Forest as a Factory" (NATURE, February 26, p. 243). In spite of the handicaps of loss of man-power and shortages of plant and equipment, the saw-milling industry of Australia rose to the emergency and increased production to a peak which fulfilled all demands at the time. Latterly, however, there has been a serious decline owing to lack of labour, trucks, tractors, spare parts and so forth—rather like the position of farming and its mechanization, in some parts at least, of Britain. It is not surprising to read that some States in Australia which were previously exporters are now importers, and that the timber control authorities have had to reorientate the flow and usage of timber. Civilian demands are treated very much as in Great Britain, and plywood is said to be already unprocurable. It is difficult to foresee what will be the ultimate demands upon the forests of the country, but it appears certain that a careful consideration of a future forest policy for the continent as a whole will be essential, if the country is not to be faced with the twin evils of increasing aridity and depreciation of water supplies, the usual aftermath of excessive and hurried forest fellings, no matter how justified these may be at the present time.

That the possible post-war needs are realized is indicated by the following quotation: "Timber, the raw material for such a widespread national industry as sawmilling, as well as paper and pulpwood manufacture, plywood and wall board fabrication, etc., can only be obtained in continuing supply under a well-planned and uninterrupted forest policy". The value of a long-term planting scheme is demonstrated by the exotic pine forests in the south-east of South Australia, from which 40,000,000 super feet of soft-wood are now being cut annually where originally there was only inferior hardwood forests of very limited extent. "The establishment of plantations and the successful regeneration of heavily-cut forests will require the skill and experience of trained foresters in greater numbers than are available to-day. For this reason alone there is a necessity to initiate the immediate training and education of men who can be called upon later for this work. State authorities would help the post-war problem considerably by giving urgent attention to this most important question. In some cases this will involve, as in the case of other professional training, a temporary loss of services to the armed Forces, which, however, must themselves benefit from this very training." Both New Zealand and Australia have recognized the wisdom of this latter step; the Ministry of Labour and National Service in Great Britain has so far found it difficult to appreciate this aspect of the problem.

The Planetary Companion of 61 Cygni

DR. ROBERT AITKEN has given a short account of the new companion to 61 Cygni, which has aroused considerable interest because of its planetary nature (*Astro. Soc. Pacific*, Leaf. 177; 1943). In 1914, Hertzsprung perfected a photographic method for measuring the motion in double stars, and this method gave results of much higher accuracy than those obtained by other means. It is considered that the photographic measurements made by this method by Hertzsprung with the long-focus telescopes at Potsdam and at the Lick Observatory, and by Strand at the Sproul Observatory, are the most accurate double-star measures that have been made. When Strand plotted the measures of the two bright components of 61 Cygni, from 1914 on, he found that the curve of their relative motion was not a perfectly smooth ellipse, but a wavy line, and this wave motion could even be traced backwards from 1914 by the use of plates taken by Lewis M. Rutherford by the old wet-plate process.

There is now no doubt about the existence of the third small body, which revolves with one of the bright stars in a period of 4·9 years. The mass of 61 Cygni *C*, the name given to this small body, is about ten times that of Jupiter, and it is very doubtful whether it is permissible to extrapolate the stellar relationships between mass, temperature, luminosity and density, to such a relatively small body, which cannot be considered a normal star. Prof. H. N. Russell states (*Astro. Soc. Pacific*, Leaf. 170; April 1943) that we are dealing with a borderline body, and discusses a number of problems that arise in connexion with such a unique discovery. There is no reason why many other similar bodies should not exist, but those that are far removed from us would be difficult to discover.

Shasta Dam

THE possible effect of earthquakes has been taken into account in the building of the Shasta Dam (*Earthquake Notes*, Eastern Section, Seismological Society of America, 15, Nos. 1 and 2, Sept. 1943, p. 4). An analysis was first made, according to Kenneth B. Keener, of the conditions existing both when the reservoir is full and when it is empty, each with and without earthquake effects, and in view of this analysis certain assumptions were made. These assumptions were then taken into account when designing the structure of the dam. The assumptions were: (1) the uplift pressure is not affected by the earthquake shock; (2) the horizontal and vertical components of an assumed earthquake shock have an acceleration equal to one tenth gravity, and a vibration period of one second; (3) the horizontal component has a direction of vibration normal to the axis of the dam.

Bibliography of Seismology

THE Bibliography of Seismology, published at the Dominion Observatory at Ottawa and compiled by Ernest A. Hodgson (13, No. 13, items 5440–5563. January to June 1943), has just been received. It contains items of interest to seismologists from almost pure geology, physics, chemistry and applied mathematics through pure seismology to notices of seismic patents for prospecting. Several items have already been noticed in the columns of NATURE. Interesting applications of seismology occur in items 5,480 and 5,500. The former concerns "Instruments for Measuring Vibrations in Grand Coulee Dam" and refers to *Engineering News Record*, 129, 64 (New York, Dec. 31, 1942). The latter, by Ernest A. Hodgson, refers to "Rockburst Research in Lake Shore Mines" and is to be found in *Miner and Mine*, 1, No. 1, 4–5, Kirkland Lake, March 1943. Item 5562 refers to a most careful piece of work by Harry O. Wood, "Earthquakes and Disturbances to Leveling in the Imperial Valley", and is taken from *Bulletin of the Seismological Society of America*, 32, No. 4, 257–268 (Berkeley, Oct. 1942). The United States Coast and Geodetic Survey surveyed the area by precise levelling in 1926–27, 1928 and 1931, and sent a field investigation unit to the Imperial Valley, California, in 1930, after the earthquakes of February 25 and March 1, 1930. The author's opinion of the probable cause of the change in levels between 1927–28

and 1931 is the slumping and compaction of the water-charged ground near the surface, with local buckling, due to vigorous shaking in 1930. The gross changes which occurred in 1940 were of a wholly different order. The occurrence of the 1940 earthquake with disclosure of a surface fault offset necessitates review and reconsideration, and may, according to H. O. Wood, point to activity along the fault zone in 1930, though the other opinion may be upheld. The author emphasizes the necessity for frequently repeated precise surveys.

Soil Erosion in New Zealand

In an article entitled "Contrasting Regional Morphology of Soil Erosion in New Zealand" (*Geog. Rev.*, January), Mr. K. B. Cumberland directs attention to the seriousness and rapidity of soil erosion in New Zealand, not merely in the wet region of the North Island but also in certain comparatively dry areas in the South Island. In the south-west of the North Island, the horizontally bedded mudstones, sandstones, marls, etc., were continuously forested until some fifty years ago, when intensive pastoral invasion began. Some forest still remains, but over-grazing has tended to decrease vegetation and allow gullying and soil flow to take place on an alarmingly destructive scale. Some of the area is reverting to bush, but without active reafforestation the harm cannot be checked. In the South Island the drier central Otago basin originally had a steppe covering. Here the destructive features of occupancy have been burning, over-grazing and rabbits. The removal of close plant cover has exposed the surface soil to the action of wind, frost and moving water, and its removal is facilitated by the nature of the rock, mica schist, which readily crumbles. Thus much land is being wasted. Lastly, the sluicing and dredging of gold mining is making havoc in places. These are but two examples of a menace that appears to be as widespread in New Zealand as in many other lands.

Guthrie Lecture of the Physical Society

The twenty-eighth Guthrie Lecture of the Physical Society is to be delivered by Dr. Joel H. Hildebrand, professor of physical chemistry in the University of California, at the Royal Institution, London, at 5 p.m. on April 26, and at the Clarendon Laboratory, Oxford, at 2.30 p.m. on April 29. Prof. Hildebrand's presence in England enables the Society to add his name to the select list of Americans who have delivered the Guthrie Lecture: R. W. Wood (1914), A. A. Michelson (1921), P. W. Bridgman (1929) and A. H. Compton (1935). He is known for his long record of research on solubility and solutions, and will take "The Liquid State" as the subject of his lecture.

Institute of Physics: Scottish Branch

Physicists employed in industry in Scotland have for some time felt the need of local opportunities for the interchange of knowledge and experience of applied physics. At their request the Board of the Institute of Physics has therefore authorized the formation of a Scottish Branch of the Institute, which is to be centred in Glasgow. The inaugural meeting of the Branch will take place on April 22 at 2.30 p.m. in the Chemistry Buildings of the University of Glasgow. Mr. E. R. Davies, a vice-president of the Institute and director of research at Messrs. Kodak, Ltd., will deliver an illustrated lecture on "High-Speed Photography, and its Applications in Science and Industry". Admission is free and without ticket. Further particulars of the Branch may be obtained from the acting honorary secretary, Dr. R. S. Silver, c/o Messrs. G. and J. Weir, Ltd., Cathcart, Glasgow, S.4.

Part-time Day Advanced Mining Scholarships

The Miners' Welfare Commission invites applications for a limited number of part-time day advanced mining scholarships tenable, as from September next, at approved institutions providing day classes in advanced mining instruction. Candidates for these scholarships must be wage-earning coal mine-workers, have been so employed for not less than eighteen months, at least seventeen years of age on September 1, 1944, and have satisfactorily completed an approved part-time senior mining course. Each scholarship will be awarded in the first instance for one year but will be renewable up to a total period of four years. The awards consist of a sum not exceeding £30 to cover fees, books, instruments and travelling expenses and to compensate or assist the student for loss of wages in attending the course one day weekly (or two half-days). The scholarships will be awarded on the results of a competitive examination. Application forms can be obtained from the principals of the chief mining schools.

Announcements

The following were elected officers of the Royal Astronomical Society at the annual general meeting: *President:* Prof. E. A. Milne; *Treasurer:* Mr. J. H. Reynolds; *Secretaries:* Dr. H. R. Hulme and Mr. D. H. Sadler; *Foreign Secretary:* Sir Arthur Eddington.

Mr. R. N. Johnson, formerly research chemist with Messrs. Tootal Broadhurst Lee Co., Ltd., has been appointed administrative officer to the British Leather Manufacturers' Research Association.

The following appointments have been made in the Colonial Forest Service: R. F. Clarke Butler-Cole, assistant conservator of forests, Nigeria, to be senior assistant conservator of forests, Nigeria; D. McIntosh, assistant conservator of forests, Nigeria, to be senior assistant conservator of forests, Nigeria.

The British Mycological Society is making a collection of surplus reprints and pamphlets on mycology and plant diseases for distribution after the War to libraries and centres of research at home and abroad which have suffered loss or damage. Authors are invited to send reprints of their own published work and any other reprints or pamphlets which they can spare to Mr. G. C. Ainsworth, secretary of the British Mycological Society, Imperial Mycological Institute, Ferry Lane, Kew, Surrey.

The twenty-fifth anniversary of the formation of the Wireless Section of the Institution of Electrical Engineers will be marked by a commemoration meeting and dinner to be held on May 3. At the commemoration meeting short addresses will be delivered, comprising a review of wireless progress, by past chairmen of the Section, there will be a short gramophone recital dealing with important events in wireless development and, if time permits, films will be shown of Sir Ambrose Fleming and Sir Oliver Lodge. An exhibition of apparatus of historical interest, kindly loaned to the Institution by the British Broadcasting Corporation, Marconi's Wireless Telegraph Co., and others, is being arranged.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Action of Inert Dusts on Insects

Kitchener, Alexander and Briscoe[1,2] have proved conclusively that certain chemically inert dusts kill insects by causing them to dry up. The effective dusts increase evaporation through the cuticle—possibly, it is suggested, because the "epicuticle fat film" is preferentially attracted by the crystalline forces at the surface of the solid particle of dust, thus interrupting the continuity of the film over submicroscopic areas. These authors found that the effect was produced only on living insects.

From observations, mainly on the bug Rhodnius but confirmed in other insects, it appears that an important factor in the action of the dusts is the simple abrasion of a film of wax (probably associated with protein) which lies outside the epicuticle. If alumina dust is applied generously to all parts of a living Rhodnius nymph suspended in mid-air, evaporation is not increased (see accompanying table). But if the insect runs on filter paper lightly treated with the dust it is completely desiccated within twenty-four hours. As the Rhodnius nymph walks, its abdomen touches the ground. But if this is prevented by placing a little mound of wax on the bearing surface, although the insect soon becomes covered with the dust, it will survive for many days, such increase in evaporation as occurs being due to the chance abrasion of other parts and to the dust getting between the moving articular surfaces. A smaller increase in evaporation results if the insect runs on emery cloth (see table).

Treatment of Rhodnius 5th stage nymphs (recently fed)	Average loss of weight per cent in 24 hours in dry air at 30° C.
Running on clean filter paper	2·2
Suspended in air and heavily dusted with alumina	1·9
Running on emery cloth No. 0	7·8
Running on filter paper lightly dusted with powdered quartz (0·5–1 μ)	17·8
ditto, with a mound of wax on the main bearing surface	5·2
Running on filter paper lightly dusted with alumina	43·5
ditto, with a mound of wax on the main bearing surface	7·6

It is well known that the outer layers of the insect cuticle contain polyphenols[3,4] which will reduce ammoniacal silver hydroxide. But if the insect is immersed in the silver solution no blackening occurs. There is clearly some protective layer outside the epicuticle. If a Rhodnius nymph which has been running on dusted filter paper or on emery cloth is so treated, however, all the prominent portions of the cuticle, where this has been in contact with the surface, are stained deep brown: the protective film has been abraded (Figs. 1, 2). Before treatment with silver the cuticle shows no change that is detectable with the microscope; there is no visible injury to what is commonly referred to as the epicuticle.

If the insect is kept in a moist atmosphere after rubbing lightly with the dust, its impermeability to water is largely restored; and after some days the rubbed area is covered with a waxy bloom. This recovery does not take place in the insect treated

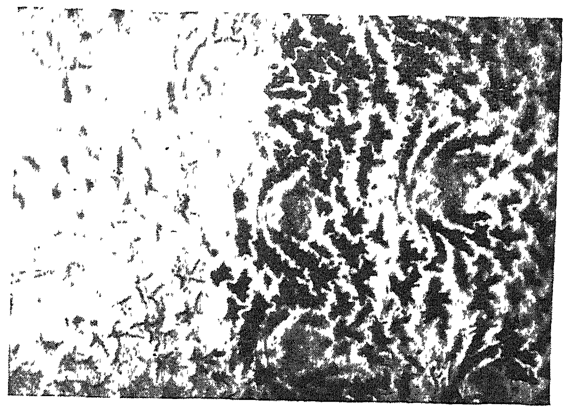

Fig. 1. Cuticle of Rhodnius treated with ammoniacal silver. Reduction is limited to the crests of the epicuticular folds of the area to the right which has been rubbed by the dust.

with cyanide. It is far less complete if the dust is allowed to remain on the cuticle; showing that, as suggested by Kitchener *et al.*[1], adsorption of the wax is important, at least while it is being secreted. The wax appears to be secreted, not by dermal glands, but through the substance of the cuticle by the epidermal cells. This raises some interesting physical problems.

These observations have a bearing on the passage of insecticides through the cuticle. It has often been observed that certain dusts favour the action of insecticides[5]. Perhaps they do so in virtue of their

Fig. 2. Puparium of Calliphora lightly rubbed with alumina showing the reduction of silver over the prominent folds.

abrasive or adsorptive properties. If 2 per cent nicotine is applied in a capsule to a standard area on the back of a Rhodnius nymph[6], the insect is slightly affected in six hours, badly affected though not collapsed in twenty-four hours. If the back is first lightly rubbed with alumina dust, complete collapse occurs within twenty minutes. If powdered rotenone (Stafford Allen 90 per cent) is used, the normal insect remains alive for weeks; the insect treated with the dust shows weakness in eight hours and is dead in less than twenty-four hours. It may therefore be desirable deliberately to incorporate abrasive material as an adjuvant in insecticidal dusts.

This work forms part of a comparative study of the physiological properties of the waxes in the

cuticle of different insects which will be published in full elsewhere. A parallel study of the isolated waxes is being made in this laboratory by Mr. J. W. L. Beament.

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March 8.

[1] Kitchener, Alexander and Briscoe, *Chem. and Ind.*, **57**, 32 (1943); *Trans. Faraday Soc.*, **40**, 10 (1944); *Ann. Appl. Biol.* (in the Press).
[2] Briscoe, *J. Roy. Soc. Arts*, **91**, 593 (1943).
[3] Schmalfuss, *et al.*, *Z. vergl. Physiol.*, **24**, 493 (1937).
[4] Pryor, *Proc. Roy. Soc.*, B, **128**, 393 (1940).
[5] Turner, *J. Econ. Ent.*, **36**, 266 (1943).
[6] Wigglesworth, *Bull. Ent. Res.*, **33**, 205 (1942).

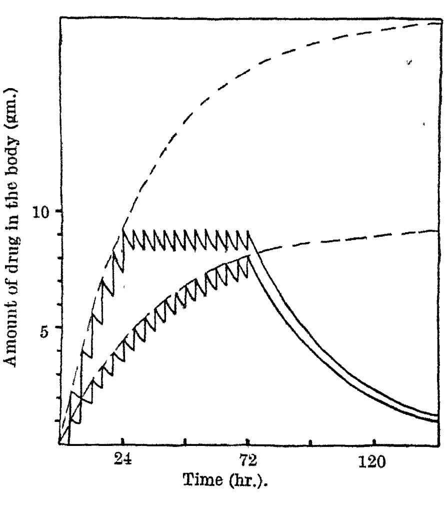
Repeated Doses of Drugs

THE following calculations, which deal with the theory of the accumulation of drugs in the body, involve two assumptions which are known to be justifiable in certain cases. The disappearance of the drug from the body is assumed exponential, and the time taken for absorption and distribution is neglected.

Let a series of equal doses (d) be given at equal intervals of time (t') in such a way that no dose is given at zero time and the first dose is given at time t'. Let the concentration produced in the body, or in the plasma, by one dose be d. Let the total concentration at time t be D, and let the drug disappear according to the formula $\frac{dD}{dt} = -kD$, or $D = D_0 e^{-kt}$. At the end of the second interval of time, $D = de^{-kt'}$, or dp, where $p = e^{-kt'}$. Immediately after the second dose, $D = d(1 + p)$, and immediately after the n^{th} dose, $D_n = d(1 + p + p^2 + \ldots + p^{n-1})$. The expression for the sum of this series gives $D_\infty = d/(1 - p)$. This expression can also be deduced from the fact that, when the curve ceases to rise, the effect of each dose (d) must exactly replace the amount disappearing between doses $[D_\infty(1 - p)]$. Simple algebra gives the result

$$D_n/D_\infty = 1 - p^n = 1 - e^{-knt'} = 1 - e^{-kt}.$$

The maxima of the curve of accumulation therefore lie on a curve which is identical with the curve of the disappearance, but inverted. This is true whatever the dose and whatever the dose interval. The curve through the minima lies below the curve through the maxima at a constant distance corresponding to the size of a single dose. It is thus possible to predict the accumulation of a drug from a knowledge of its disappearance.



Curves of accumulation. Time for half-clearance = 24 hours; $1/k$ = 34·6 hours; t' = 4 hours; p = 0·891. *Lower curve*—d = 1 gm.; D_∞ = 9·2 gm. *Upper curve*—first 6 doses = 2 gm.; D_∞ = 18·4 gm.

The time taken for a drug to accumulate in the body is often too slow for therapeutic requirements and is diminished by giving large doses in the early stages of treatment. It may be calculated that, if the dose, or the rate of dosing, is doubled, the time taken for the curve through the maxima to reach 90 per cent of its final value on single doses is reduced to about 26 per cent of the time which would be taken if single doses were used throughout. If the dose is quadrupled, the time is reduced to about 12 per cent, provided that the approximations mentioned above are still valid.

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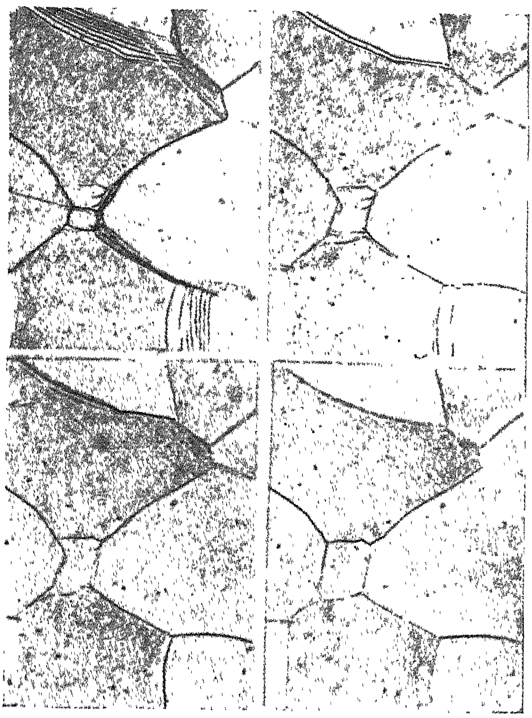
March 21.

Thermal Fatigue of Metals

WHEN small steel-backed bearings of tin- and lead-base alloys were repeatedly heated and cooled over the range 30°–150° C., marked cracking occurred throughout the tin-base alloy, but not in the lead-base alloy. Continuation of the cyclic process led ultimately to the disruption of the tin-base alloy. Since specimens of similar alloys *unattached* to a steel shell were found to behave in the same manner, it was thought that the metals forming the bases of the alloys were responsible for the difference in behaviour. For this reason, lead (99·99 per cent) and tin (99·9 per cent) were examined under the same conditions, the investigation being later extended to cadmium (99·97 per cent), zinc (99·97 per cent) and tellurium (B.D.H. Purity).

The specimens of lead, tin, cadmium and zinc were in the annealed state and all but lead were electrolytically polished. The lead specimens were prepared by careful polishing followed by etching with the usual acetic acid – hydrogen peroxide reagent. These methods were adopted to obtain surfaces for metallographic examination which were free from deformation. The specimens were then alternately heated and cooled over the range 30°–150° C. for a number of cycles. In the case of tin, cadmium and zinc, this treatment produced definite signs of plastic deformation, indicated in some cases by twinning and in others by slip lines. Photomicrographs illustrating the effect for cadmium are reproduced herewith. Close examination of lead specimens treated in the same manner failed to reveal any evidence of plastic deformation.

In the majority of cases, plastic deformation was observed even after one cycle, but it was limited to a few grains only. As the number of cycles was increased, signs of plastic deformation appeared in more grains and became more pronounced in individual grains until finally most grains were affected.



Thermal fatigue of pure cadmium (× 300) after heating from 30° to 150° C. and cooling: (a) as polished; (b) after 1 cycle; (c) after 2 cycles; (d) after 15 cycles.

Variation in the duration of the cycle and the rates of heating and cooling made no perceptible difference to the magnitude of the effect. Variations in the length of the cycle from 7 minutes to 6 hours, that is, a ratio 1 : 50, did not alter to any great extent the degree of deformation obtained.

In order to investigate the effect of temperature, specimens of cadmium were observed under the microscope while heating and cooling. It was found that the lines indicating deformation appeared mainly on heating; thus apparently the heating portion of the cycle was responsible for the greater part of the deformation. It was clear that plastic deformation occurred even after small temperature changes, but became much more pronounced with further rise in temperature, until at 150° C. the effect was very marked.

It was noted that the magnitude of the effect varied with the metals used. Plastic deformation occurred more readily in cadmium than in tin, while the effect in the case of zinc was at least as pronounced as in cadmium. When cadmium was cast on glass plates, examination of the mirror-like undersurfaces of the globules formed revealed distinct slip and twinning. Tellurium behaved somewhat differently because of its brittle nature. On the undersurfaces of tellurium globules cast on glass or mica, slip lines and even cracks were seen. After a number of cycles, some of the cracks extended.

Examination of cadmium specimens after each cycle showed that considerable movement of grain boundaries occurred. This migration was also very evident in the case of tin. It seems to be associated with the plastic deformation in the grains. Some grain boundaries moved more than others, while some were quite stationary. Many instances were detected where a grain boundary impression was formed after each cycle, with the result that, finally, a network of boundaries was formed. Such a boundary migration was detected in a tin-base alloy by Carpenter and Elam[1], who used the phenomenon to trace the growth of crystals on annealing after deformation. Rosenhain and Ewen[2] found that when mechanically polished silver was annealed, twins were formed. This twinning was apparently due to mechanical deformation by this type of polishing. It is evident that this phenomenon is different from that described above. Furthermore, these authors did not find a similar effect with zinc.

The name 'thermal fatigue' is suggested for the effect because of its analogy with that of repeated *external* stresses on metals. In both cases, the specimen is subjected to cycles of stress which produce plastic deformation of the crystals. If the stress is larger than a certain limit, progressive damage is done, and finally failure occurs. The cause of the stresses in the specimens of *non-cubic* metals subjected to thermal cycles seems to be the anisotropy of thermal expansion. This explanation is supported by the fact that no deformation of this type has been detected in the cubic metal lead, whereas it has been found in tin, cadmium and zinc, which are non-cubic metals possessing marked anisotropy of thermal expansion[3]. The theory is further supported by the observation that the rates of heating and cooling of the specimens seemed to be of little significance. An approximate calculation shows that the stresses developed in the crystals are proportional to the temperature change, the difference between the maximum and minimum coefficients of thermal expansion of the crystal, and an average value of Young's modulus[4]. The ratio of the stress to the critical shear stress of the crystal may be used to indicate the likelihood of plastic deformation, although this is only a first approximation. The numerical values indicate that the metals lie in the order, tin, cadmium, zinc, with respect to the increasing probability of occurrence of plastic deformation for a given temperature range. The experiments seem to be in agreement with this classification.

It appears, therefore, that metals which possess a high degree of anisotropy of thermal expansion cannot be obtained in a strain-free condition at room temperature by casting or annealing. It is possible that deposition from the gaseous state might give strain-free crystals. Apart from its theoretical interest, the effect has implications in the field of bearings where tin-base and cadmium-base alloys are in common use. Many such bearings are subject to frequent temperature changes of the order of 100° C., and the phenomenon described might well contribute to their ultimate failure in service.

We wish to express our thanks to Dr. F. P. Bowden for his interest and encouragement in the work.

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[1] *J. Inst. Metals*, **24**, 83 (1920).

[2] *J. Inst. Metals*, **8**, 171 (1912).

[3] Schmid, E., and Boas, W., "Kristallplastizität", p. 202.

[4] A calculation has been made by F. Laszlo in his papers on tessellated stresses, *J. Iron and Steel Inst.*, 1943.

Bacteriological Diagnosis of Gas Gangrene due to *Clostridium oedematiens*

IN gas gangrene infections it is important to determine the infecting organism as quickly as possible, but hitherto there has been no satisfactory method available for the rapid recognition of *Cl. œdematiens*. By means of the cultural reaction described below, it is hoped that it will usually be possible to make a provisional diagnosis in less than twenty-four hours. With heavily sown or overgrown plates, in which the reaction may be doubtful, it may be necessary to subculture without delay from a suspected colony to a fresh plate.

The medium employed is a modified Weinberg's V.F.[1] agar (2·25 per cent) to which 10 per cent defibrinated sheeps' blood and 10 per cent egg yolk suspension is added. The egg yolk suspension consists of equal parts of normal saline and egg yolk freshly removed from an egg aseptically. In surface cultures on plates of this medium, colonies of *Cl. œdematiens* attain a diameter of 0·8–1·5 mm. after 16 hours incubation anaerobically. Colonies of *Cl. œdematiens* type *A* are surrounded by a hæmolytic zone outside which is a dark red 'reduction' zone. Covering the colonies and the hæmolytic zone is an opaque film with a mother-of-pearl lustre. All available species of Clostridia and a number of common aerobes have been tested, but none of them produces both the pearly layer and the reduction zone together, although some species show one or the other feature separately.

Although we have had the opportunity to test this method of diagnosis on actual clinical material in only five cases to date, our experience with these cases and with artificially mixed cultures suggests that it will be possible to detect *Cl. œdematiens* type *A* in material from lesions in which various other organisms are present. Swarming is avoided by opening and drying the plates for approximately five hours in the incubator before inoculation.

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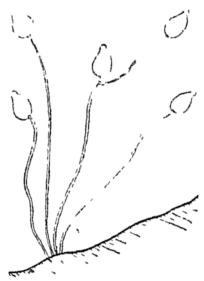
Victoria.

[1] Described as "peptic digest" by Carne, H. R., *J. Path. and Bact.*, 51, 199 (addendum p. 212) (1940).

Species of Phytophthora as Water Moulds

AT the last meeting of the British Mycological Society I directed attention to the fact that (although omitted from published lists of water moulds), parasitic species of Phytophthora may live for long periods of time as water moulds. Masquerading thus as saprophytes, they may be dispersed in water and carried to fields where they may become parasitic upon crops. I suggested that with the co-operation of fellow mycologists, naturalists, microscopists and 'pond-dippers', it should be possible to determine the distribution of these species in the streams, ponds, ditches, even bird-baths, of Britain; and I appealed for helpers. I should be grateful for space in NATURE for the following instructions on how to find, and to send to me, anything that looks like a possible member of the Pythiaceæ, collected in this way.

Method. Collect from streams, ponds, etc., half-decayed fruits, twigs, stems of water weeds which are bearing a straggling, greyish mycelium probably in a bacterial slime. It may be necessary first to put the fruits, etc., into the water, that is, to 'set bait', and this is best done in some container (within which the bait will not be reached and eaten by goldfish, snails, etc.).



Bait. (1) Fruits. hips, haws, windfall apples, small tomatoes and other berries. (2) Seeds, for example, hemp. (3) Thin twigs and leaf stalks, cut into short lengths.

Container. (1) Galvanized tin with holes punctured in the top and bottom. (2) Glass jar with coarse muslin stretched over the mouth.

Treatment. Allow from a few days to a month or more to pass before gathering bait (leaves and soft fruits are attacked by fungi more quickly than are twigs and seeds). Wash the 'bait' well in tapwater, and keep it in the dark. It is possible that sporangia may not appear until after the water has been changed.

Identification. Hyphæ: coenocytic (no cross walls), of various widths, branched. Sporangia: ovoid with papilla, borne at the end of a slender hypha.

Transport. Drain the material collected and wrap in damp paper; enclose it in a tin and post it to me with the following particulars (and, if possible, drawings): (1) nature of substratum or 'bait'; (2) nature of water, (*a*) flowing or stagnant, (*b*) acid (alkaline or neutral), (*c*) depth; (3) date of collection, and, if bait set, date of setting bait; (4) any further treatment.

Material will be most appreciated this year in May, June, September, October, November. I will refund postage and, if asked, return the tin. I shall gratefully acknowledge, in any subsequent report, all help given.

ELIZABETH BLACKWELL.

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March 11.

Variation in the Nitrogen-fixing Property of *Rhizobium trifolii*

WHILE testing a number of strains of *Rhizobium trifolii*, two cases have occurred (cultures 61 and 91, isolated from *Trifolium tomentosum* L. and *Trifolium glomeratum* L. respectively) in which a culture, from a single colony developed from a single nodule, has shown at the time of its first testing on white clover (*T. repens* L.) the presence of definite 'sub-strains' with distinctly different nitrogen-fixing ability. Culture 91 showed the same behaviour when tested against *T. glomeratum*. In each case, while some plants were scarcely better than those of the uninoculated control, other plants in the same pot were very much better. The former showed the usual characteristics associated with inefficiency, namely, early yellowing of cotyledons, poor yellow growth and the presence of many small nodules. The healthier plants carried typically large effective nodules, although other smaller nodules, similar to those on the poorly grown plants, also occurred.

Re-isolations were made from weak and vigorous plants and from small and large nodules. Re-isolates from both 61 and 91, when tested serologically against sera of studied antibody constitution[1], gave the same reactions as the original culture. Antibody absorption tests confirmed this result. This serological identity of the 'sub-strains' argues conclusively against the possibility of contamination, particularly in the case of 91, which represents an uncommon serological form which has been encountered on only one other occasion in about a hundred isolations from a wide range of plants. Re-isolates from 91 were tested for efficiency with cluster clover (*T. glomeratum* L.) grown on Crone's agar in large tubes plugged with cotton wool, observing the usual precautions. Results are set out below:

Re-isolate	Effectiveness	
Pot 7, LL	Effective	LL: large nodule, large plant.
,, SL	Ineffective	
,, SS	Ineffective	SL: small nodule, large plant.
Pot 12, LL	Effective	
,, SL	Ineffective	SS: small nodule, small plant.
,, SS	Effective	

There seem to be three possibilities: (1) The original nodules carried 'sub-strains' which belong to the same fundamental strain, as judged on serological evidence, but have at least two distinct levels of nitrogen-fixing ability (always in respect of a particular host). (2) A variation occurred in culture within a short time (several months) and in the course of relatively few sub-cultures, following isolation. (3) Exposure of the organism to the test plant caused an immediate variation. It is felt that the first of these alternatives is the most likely explanation. Experience with Pot 12,88 might be contributory evidence. The selection of an effective culture from what seemed to be an inefficient nodule might have been due to the nodule carrying organisms of different nitrogen-fixing ability.

The apparent lability of characteristics in the organism which affect its ability to form an effective association with a particular host contrasts with the serological stability revealed in previously reported studies[1,2,3] and agrees with the experience of other workers (as, for example, Allen and Baldwin[4]). However, in respect of the plant passage experiments of the last-named workers, it is suggested that the experience reported in this note raises the possibility that the change in efficiency attributed by them to plant passage might have resulted from a selection of already existing variants rather than from variation induced by repeated exposure to the host plant. The results also emphasize what is continually being found in this laboratory, namely, the lack of any apparent relationship between serological constitution (as revealed by present techniques) and the factors responsible for efficient association with a host plant. Serological methods, however, have considerable value in the designation of strains and provide a convenient basis for reference in connexion with several aspects of root-nodule investigations.

J. M. Vincent.

School of Agriculture,
University of Sydney.
Feb. 22.

[1] Vincent, J. M., *Proc. Linn. Soc., N.S.W.*, **67**, 82 (1942).

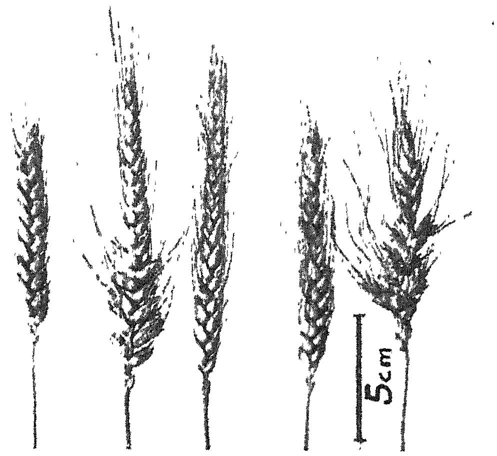
[2] Vincent, J. M., *Proc. Linn. Soc., N.S.W.*, **66**, 145 (1941).

[3] Hughes, D. Q., and Vincent, J. M., *Proc. Linn. Soc., N.S.W.*, **67**, 142 (1942).

[4] Allen, O. N., and Baldwin, I. L., *Wis. Agric. Res. Stat. Res. Bull.* 106 (1931).

Branched Heads in Wheat and Wheat Hybrids

The accompanying photograph shows the parents and *F*1 progeny of a cross between a normal bearded bread wheat (*Triticum vulgare*, Host, $2n = 42$) and a branched or 'miracle' headed rivet wheat (*T. turgidum*, L., $2n = 28$). *A* is a head from the pure line used as the female and *B* one from that used as the male, both from plants grown out of doors. Half the hybrid grains were started in Petri dishes on December 30, 1942, and the seedlings transferred about a week later to a greenhouse heated just sufficiently to keep out frosts. The remaining half was treated in the same way about the first week in the following February (the exact date is unfortunately lost).



A *C* *D* *E* *B*

When the *F*1 plants had headed it was seen that all those first sown bore branched heads, one of which is shown at *C*, while all those sown later bore completely unbranched heads (*D*) exactly like the female line in this respect. When the plants tillered, these heads were unbranched, both in the case of the first sown plants (*E*) as well as in the second group.

The branched-headed character is caused by some of the lower buds, which normally only develop into single spikelets, growing out vigorously and so producing small heads of their own. This character is usually stated to behave as a simple recessive to the normal unbranched condition (Percival[1] quoting Tschermak), but apparently this is only part of the story. It would seem that the expression of this allele is greatly influenced by the day-length and perhaps the temperature under which the plants are growing. The variation described above correlates well with the observations of Hurd-Karrer[2] on the growth of normal winter and spring bread wheats when kept under constant low (12° C.) and high (21° C.) temperatures and short (8 hr.) and long (17 hr.) days. She found that at both low and high temperatures, short days produced long heads, the lengthening being most pronounced at the low temperature and mainly due to an increase in the distances between the lowermost spikelets. Under conditions of short days and low temperatures a secondary head was sometimes produced from the axil of the topmost leaf, and in Turkey, the winter wheat used, the main heads were often branched giving miracle-headed bread wheats.

Long days produced very short heads. In the winter wheat used, long days and the higher temperature often led to a failure to produce heads at all but resulted in the development of an elongated shoot with multiple vegetative branching at the nodes—a state similar to that commonly found in England in Agrostis, Festuca and Holcus during the autumn and called by Arber[3] the "pompon or mop habit".

Temperature	Short → Long Day-length	
High ↑	Long heads (2)	No heads + pompon habit or Short heads (4)
Low	Long heads or Branched heads (1)	Short heads (3)

If the above table represents the general interactions of day-length and temperature on wheat, then in homozygous branched-headed *T. turgidum (bh bh)* the area of the rectangle 1 is comparatively large so that normal sowing will fall within these limits and miracle heads be produced. In the heterozygotes, *Bh bh*, resulting from the cross normal *T. vulgare (Bh Bh)* × branched-headed *T. turgidum (bh bh)* the rectangle is smaller, so that in the greenhouse, at any rate, only early sowing will give miracle heads; tiller heads from early-sown plants and main and tiller heads of late-sown plants will be developing under conditions outside this rectangle. The area is smaller still for normal winter bread wheat, *T. vulgare (Bh Bh)*, but as Hurd-Karrer has shown, short days and low temperatures will still give miracle heads. Presumably still shorter days with or without lower temperatures would give branched heads even in normal spring bread wheat.

There are limits outside which homozygous branched-headed *T. turgidum* itself will not produce miracle heads. With the late-spring sowing usually necessary for outdoor material in Leeds, in some years the pure lines show very little branching: one year, in fact, the only trace was the presence of occasional double spikelets at the base of the heads. Presumably this is due to the relatively early onset of long days in this latitude. With spring sowing, at any rate, it has never been possible to produce here the magnificent branched heads figured in the literature. The average reached is about that shown at B, although the parent head of this line (generously given by Mr. A. E. Watkins from his Cambridge-grown material) was considerably more branched.

It would seem that the branched-headed factor operates by altering the branched/normal-headed threshold and so can be made to behave as either a dominant or a recessive at will.

B. C. SHARMAN.

Botany Department,
University, Leeds 2.

[1] Percival, J., "The Wheat Plant" (London, 1921).
[2] Hurd-Karrer, A. M., *J. Agric. Res.*, **46**, 867 (1933).
[3] Arber, A., "The Gramineæ" (Cambridge, 1934).

Simple Sensitive Flames

IN his letter which appeared in NATURE on March 25, Dr. Sutherland sets out to show, if I understand him aright, that a sensitive flame possesses certain very sharply defined frequencies of response, independent of the parameters of the jet, which is certainly "surprising and difficult to explain", especially with this very heavily damped system. What exactly these frequencies are I am unable to decide from his diagram, since I note that two of the three sharply defined maxima of his lower diagram agree exactly with sharply defined minima in the upper diagram. Perhaps this is significant?

In the paper which he quotes[1] I showed, working with a liquid-into-liquid jet, which is much better adapted for quantitative work than a flame, that these very sharp responses undoubtedly existed, but that many of the frequencies could be traced to resonances of the supporting structure, since they could be easily varied by loading it. I also brought forward evidence that the others were due to resonances of the room. Further, if the disturbance of the jet was produced by a small local vibrator, a centimetre or so from the orifice, which was too feeble to act appreciably on the framework or on the room, there was the same type of general response as was produced by the ordinary sound source but no selective response at all. This appeared to me conclusive.

If Dr. Sutherland should feel that the matter really needs "a critical comparative examination" of what he calls "the two claims" by an authority of weight, I venture to suggest that he start his investigation by repeating my experiment of vibrating in still air the orifice from which the flame issues. If he gets sharply defined response at the same frequencies as he now gets by using a heavy sound source in the room, which means vibrating the air past the orifice, (and in my opinion, but not in his, also means producing resonant effects in room and structure), he will have gone some way to prove his point. If, however, he does not, he will be confronted with another conclusion, likewise surprising and difficult to explain, namely, that the motion of the orifice relative to the air produces a totally different effect from a like motion of the air relative to the orifice.

I failed to get any selective response at all when vibrating the orifice, either with a liquid jet or with a flame, although the general response was the same as with the normal procedure, but it would, needless to say, be a great satisfaction to me to have the result confirmed by Dr. Sutherland.

E. N. DA C. ANDRADE.

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London, W.1.

[1] Andrade, E. N. da C., *Proc. Phys. Soc.*, 53, 329 (1941).

The Sycamore Tree

IN Mr. Alexander Howard's interesting article in NATURE of March 18 on the sycamore tree, he did not mention the very remarkable aeronautical properties of its seed. It is the outstanding example of Nature making use of the autogyro in flight, and with a single-winged rotor.

Attempts have been made to copy this extremely efficient method of parachuting, so to speak, but so far nothing comparable with the efficiency of the sycamore seed has been evolved.

It is also interesting as a demonstration of animate Nature using revolving mechanism, of which she is usually shy, but in this autogyro single-winged sycamore seed we have an example of a rotary movement combined with advanced aeronautics.

BRABAZON OF TARA.

70 Pall Mall, S.W.1. March 20.

IMPROVEMENT OF ECONOMIC CROP PLANTS

In these days when our thoughts tend to be concentrated on battle areas and the production of munitions of war, it is refreshing to turn to the no less essential researches and activities which have as their aim the increased production and improvement of economic plants, an activity which will also be of benefit to the world when peace is restored. For his presidential address to the thirty-first Indian Science Congress held in January at Delhi, Dr. T. S. Sabnis chose as his topic the recent advances in botany in relation to improved crop production, and he is to be congratulated on the picture he has portrayed of the very varied avenues of botanical research which all converge and have their part in contributing to this ultimate aim.

Genetics is a relatively new science, and the astonishing advances since plant-breeding was placed upon a firm foundation by the re-discovery of Mendel's papers in 1900 justifies the placing of this subject in the forefront of such an address. In the period between the two Wars, a somewhat new impetus and outlook was introduced, particularly by the Russian plant-breeders under Dr. I. N. Vavilov, into the plant-breeding experiments, in that the latter were associated with widespread search and introduction of related cultivated and wild species from other parts of the world; this line met with considerable success, since new genes were introduced into the assemblage for assortment into combinations favourable for a wide variety of habitats; some of the wild species introduced genes of increased hardiness and disease resistance which would prove of very great value if combined with some of the properties of cultivated forms. The difficulties of inducing crosses between desired types were much reduced by the discovery that sterility of interspecific, or even intergeneric, hybrids might be overcome by artificial induction of polyploidy by the use of colchicine or X-ray treatments. Thus polyploid crosses between wheats and *Agropyrum elongatum* gave promise of perennial wheats with high yield and disease resistance combined with such hardiness that they would grow in regions previously considered impossible for cultivation of wheat. Polyploidy has also been shown to have its uses in contributing greater vigour to certain types and increasing the yields of certain plant constituents, such as the vitamin C content of tomatoes and the carotinoid content of maize.

Once the significance of introducing new types into the assemblage for interbreeding is realized, it is obvious that the plant geographer who studies the distribution of species, the pure systematist who names the plants, the ecologist who studies their relationships to the normal habitat, and the botanist who is interested in the subdivision of the species into varieties and microspecies, will all have their contribution to make to the successful cultivation of the plants concerned, and the possibilities of their hybridization and introduction as crop plants into new and previously uncultivated regions. The relation of the plant to its environment is in itself a large problem, and considerable light has been thrown on this type of study by the somewhat new aspects of the work elaborated by Clements. He has taken a more dynamic view of the vegetation, and his conception of climax, succession and conservation has stressed the importance of following the changes in a vegetation and has given results of importance particularly in relation to grassland and forest cultivation.

In the field of plant physiology, the work of Gardiner and Allard on photoperiodism has enabled a technique to be evolved for bringing plants collected from different climatic zones into the flowering condition at the same time and thus rendering their hybridization a possibility.

Another important aspect of plant cultivation in new regions was the discovery by Lysenko of 'vernalization'. Previously, many plants were confined within certain temperature zones, beyond which they could not be cultivated, but Lysenko showed that by careful regulation of temperature treatment of seed the climatic barrier could be broken down: for example, many varieties of winter wheats which would not ear when sown in spring could be made to do so by vernalization.

These are the main factors discussed by Dr. Sabnis in connexion with the production of new varieties of economic plants with improved qualities, or with wider ranges of cultivation in relation to climatic or soil conditions. He referred also to the significance of certain other aspects of botanical research, such as the utilization of certain chemicals to promote root-growth, which has played an important part in problems of vegetative propagation, and the recognition of the importance of secondary elements. It is not long since only those elements necessary to plants in relatively large amounts were recognized as essential, but it is now known that other elements such as boron, zinc, silicon, etc., may be responsible for deficiency diseases and failures of certain crops, though the quantities required are extremely small.

'CHROMOSOMIN' AND NUCLEIC ACIDS

In a recent article, Stedman and Stedman[1] have reported observations which they consider to indicate the existence of a special protein, termed 'chromosomin', in cell nuclei; and, on theoretical grounds, have endeavoured to ascribe to it several previously known phenomena considered to be due to other nuclear constituents, especially nucleic acids. As regards nucleic acids, Callan[2] has put forward the experimental data against their view; Stedman and Stedman[3] have based their reply to Callan largely on references to data from my laboratory. As no reference is given to the original papers, and I regard the comments as directly misleading, a brief correction appears to be called for; in particular, it seems desirable to indicate my view of the bearing of the ultra-violet absorption measurements on the 'chromosomin' question. This is all the more necessary as Stedman and Stedman, by the wording of their communication[3], convey the impression of a thorough study (p. 504, "if one examines Caspersson's work critically one will find, as he himself admits, that . . ."), whereas of some twenty-five publications bearing on this subject, issued from 1936 onwards, only the very first has been available in the original.

Stedman intimates (p. 504) that the absorption band in the nuclear material which I had attributed to nucleic acids may actually have been caused by tryptophane. In 1936 the first two absorption spectra obtained by a photographic process were recorded by me[4]. By evidence to which Stedman does not refer, it was shown that these spectra were due to a

nucleic acid band with an overlapping protein band. With the aid of photo-electric methods developed in and first described in the following year, 1937, absorption spectra of nuclear constituents could be taken with such exactitude that these spectra can be analysed into their components (for data regarding the requisite conditions for the measurements and the treatment of the preparations as well as technical data, see, for example, refs. 4, 5 and 6). The chief subject of all the subsequent investigations with this technique—in addition to the study of the nucleic acid distribution—has been precisely the distribution of the selectively ultra-violet-absorbing amino-acids, especially tyrosine and the tryptophane, about which Stedman inquires (see bibliography in, for example, ref. 7). These investigations have shown that nuclear structures in general are largely composed of proteins containing tyrosine and tryptophane, and moreover, especially in the metaphase chromosomes, nucleic acids. Whether any of these proteins may be of 'chromosomin' type it is, of course, impossible to judge from the absorption data. The localization of nucleotides in certain nuclear areas is in no way affected by a possible finding of acidic proteins in the cell nucleus. It should further be pointed out that there is no objection in principle to the supposition that proteins rich in glutamic acid may also be present in certain of those nuclear structures, which have been shown by staining experiments and absorption measurements to contain considerable amounts of hexone bases: the procedure used will not be affected by this component.

As it may be difficult at present to obtain access to Norberg's paper in England, it should be pointed out that here too the reference is misleading. Norberg[8] (p. 90) presents his results as preliminary, in so far as much wider fields of work than those which he has yet tackled have been opened up by his technique, for chemical study. The direct chemical determinations which he has already made on certain material are not, of course, 'preliminary'; they include his analysis of the Chironomus chromosomes.

The digestion methods have been discussed in detail by me in previous papers which Dr. Stedman has not apparently seen, to which the reader is referred[5] (p. 598). Their value must always be very limited. Stedman's observation, however, is valueless without experiments made in *exactly* similar conditions as those under which ours were conducted, as it is known that proteins with iso-electric point considerably below 5 are well digestible under those conditions.

Contrary to Stedman's statement, the ultra-violet absorption data to which he refers[1] show in the resting nucleus large amounts of proteins containing tyrosine and tryptophane.

The composition of the metaphase chromosome is very different from that of a resting nucleus, and it is to be regretted that it is still inaccessible to protein analysis by chemical methods. During the development of the metaphase chromosome in the resting nucleus a marked quantitative change occurs, in that the proteins containing tyrosine and tryptophane are largely broken down, while the ratio of the total tyrosine plus the total tryptophane to the total hexone bases is, in all probability, markedly shifted in favour of the latter. This last-mentioned development varies in degree in different kinds of animals: even closely related species may show considerable differences. The development of the sperm affords an interesting parallel. Analogous conditions in this field had already been shown by Miescher; he also stated that in some special cases the change proceeded so far that the major part, though never the total amount, of the sperm protein might consist of simple protamines. In a paper cited by Stedman, Miescher himself points out, in regard to sperm, that the main features of the development are similar in different cases, but that considerable differences occur in its terminating stages. Thus neither the results of the ultra-violet investigations nor those of Miescher's chemical researches are affected in the least degree by the 'chromosomin' question. It is conceivable that such a protein may exist; in that case, however, the content thereof, at any rate in the sperm of certain fishes, must be considered to be very low.

Summing up, it may be stated that the observations made with the aid of ultra-violet absorption measurements and associated methods, in conjunction with other microchemical experiments from recent years, are neither for nor against the occurrence of a protein of the chromosomin type in certain parts of the nucleus. Nor, on the other hand, does the assumption of 'chromosomin' as an integral constituent of the nucleus in any way affect the views which, chiefly with the aid of ultra-violet absorption measurements, have been advanced in regard to the protein and nucleic acid metabolism and the distribution of those substances in the nucleus. The views to which Callan has directed attention in regard to the distribution of the nucleic acid still hold good.

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Stockholm.
Dec. 10.

[1] Stedman, E., and Stedman, E., NATURE, 152, 267 (1943).
[2] Callan, H. G., NATURE, 152, 503 (1943).
[3] Stedman, E., and Stedman, E., NATURE, 152, 503 (1943).
[4] Caspersson, T., *Skand. Arch. Physiol.*, Suppl. 8 (1936).
[5] Caspersson, T., *et al.*, *J. Roy. Mic. Soc.*, 40, 8 (1940); *Nat. wiss.*, 29, 33 (1941); *Chromosoma*, 2, 111 (1941); 132 (1941).
[6] Caspersson, T., *Chromosoma*, 1, 562 (1940).
[7] Caspersson, T., and Santesson, L., *Acta Radiologica*, Suppl. 46 (1942); Hydèn, H., *Acta Physiologica*, Suppl. 17 (1943).
[8] Norberg, B., *Acta Physiologica*, Suppl. 14 (1943).

IN papers published mainly in Germany during the War, and possibly in later papers published in Sweden, none of which was or is accessible to us through our normal library facilities, Caspersson has put forward comprehensive theories concerning the chemical nature of the cell nucleus based upon ultra-violet spectrographic studies. While we have not seen these publications, they have been summarized by Darlington[1] in NATURE, and if this summary accurately represents Caspersson's views, as we have every right to think it does, we believe they cannot survive in the light of our work on chromosomin.

The dilemma in which our opponents find themselves will be seen from the following passage taken from Darlington's article: "The use of this technique has confirmed the picture so far outlined. But it has also gone much further. It has shown that heterochromatin and nucleolus agree in having a high histone content. On the other hand, in the euchromatin the regions between the chromomeres contain globulin-type proteins. These higher proteins are lost in metaphase chromosomes or ripe sperm." We wish to direct attention particularly to the last sentence, which makes it perfectly clear that, according to Darlington's summary of Caspersson's

work, the only proteins present either in metaphase chromosomes or in ripe sperm are histones or protamines. In his present letter, Caspersson virtually agrees to this view, although he does make certain hesitating reservations. Thus, he now states that in the metaphase chromosomes "the proteins containing tyrosine and tryptophane are *largely* broken down, while the ratio of the total tyrosine plus the total tryptophane to the total hexone bases is, *in all probability*, markedly shifted in favour of the latter" (our italics). Again, he states that "Miescher's chemical researches are [not] affected in the least degree by the 'chromosomin' question. It is conceivable that such a protein may exist; in that case, however, the content thereof, at any rate in the sperm of certain fishes, must be considered to be very low". If we recall that Miescher[2] calculated from his results that the dry, lipoid-free heads of salmon sperm contained 96 per cent of protamine (salmine) nucleate, it follows from Caspersson's statement that this material cannot contain more than 4 per cent of chromosomin, an amount which might easily escape detection by chemical methods. Caspersson's theories thus fall or stand according as chromosomin is or is not present in ripe sperm and metaphase chromosomes.

In the case of sperm, a decision presents no difficulty. The direct chemical examination of fish sperm which we have already made has shown that it contains considerably more than 4 per cent of chromosomin. The amount present cannot be determined with precision since, as we have already pointed out[3], only indirect methods are at present available for its estimation. These have, however, shown that approximately ten times as much chromosomin as the maximum which Caspersson's theories will admit is present in the dried sperm heads. This estimated figure, moreover, corresponds satisfactorily with the weight of crude chromosomin actually isolated from the sperm, and from this impure material chromosomin has been prepared completely free from any other known constituent of cell nuclei. Owing to difficulties in procuring material, we have not, it is true, yet had an opportunity of examining salmon sperm itself. Our results do, however, apply to herring sperm, which has also been stated[4] to consist entirely of protamine (clupeine) nucleate. That chromosomin is present in similar amount in salmon sperm is, however, evident to anyone experienced in the chemical examination of cell nuclei from a perusal of Miescher's papers. Had modern technical methods been available to him, we have no doubt that Miescher would have added to his discovery of nucleic acid and protamine that of chromosomin.

To demonstrate the presence of chromosomin in metaphase chromosomes is a more difficult problem. As Caspersson points out, they are "still inaccessible to protein analysis by chemical methods". Unfortunately for Caspersson's theories, however, there does exist a perfectly legitimate, although indirect, method of analysing metaphase nuclei (that is, chromosomes plus spindle) which we have actually employed[5]. When cells are undergoing constant proliferation without any accompanying differentiation, the proportion of cells in active mitosis at any instant is usually small. This is due to the fact that the actual division of the cell is a rapid process, whereas the interphase between successive mitoses is a much more prolonged one. Moreover, it is a cytological principle that the mitotic division of the nucleus is meristic, so that each daughter nucleus will have the same percentage composition as the mother nucleus but only half its mass. The protracted interphase which occurs between divisions is obviously necessary for the growth of the daughter nuclei, and, if no change occurs in the character of the cells, it is legitimate to draw the conclusion that this growth has no effect on the percentage composition of the nuclei. Analyses of nuclei from cells of the type described, of which tumour cells are a good example, have shown[5] not only that they contain chromosomin but also that this protein constitutes a greater proportion of the dry nuclei than is the case with permanently resting nuclei such as those from thymocytes and avian erythrocytes. This result is again in direct conflict with Caspersson's conclusions.

But we do not depend solely on the above arguments to prove that chromosomin is the principal constituent of chromosomes. The properties which the purified material possesses indubitably point to the same conclusion. Not only does it, as we have previously mentioned[1], behave towards basic dyes in the same way as do the chromosomes, but also the remarkable avidity with which it takes up developed nucleal stain both in the purified state[6] and as a component of the chromosomes[7] leaves no doubt whatsoever as to its position in the metaphase nucleus. Moreover, its physical properties point in the same direction. Nobody familiar with the properties of histone could possibly imagine that this base could, even in combination with nucleic acid, form structures like the chromosomes which resist the action of the drastic fixatives sometimes employed in staining processes. Chromosomin, on the other hand, possesses chemical and physical properties which are eminently suited to withstand this treatment. Further, histones and protamines are too simple in structure, as Mathews[8] has pointed out, to account for the hereditary functions of the chromosomes. Chromosomin, however, is a much more complex protein which could, and no doubt does, subserve this function.

Caspersson's own spectrographic measurements are not in contradiction with our conclusions, although he seems reluctant to admit the fact. Caspersson states that his absorption spectra published in 1936[9] were shown to be due to a nucleic acid band with an overlapping protein band. His proof has eluded us, but he does say (p. 95): "Mit grosser Wahrscheinlichkeit ist die Verschiebung auf eine im Chromosom enthaltene Eiweisskomponente züruckzuführen, welche eine Absorptionskurve gleich in Fig. 12 mit einem schwachen Absorptionsmaximum 2800AE hat. Diese könnte bei einer Konzentration, welche in keiner Weise mit der der Nukleinsäure vergleichbar ist, vollkommen die Verschiebung erklären". We must point out, however, with regard to this explanation, that Caspersson estimates that the absorption produced by the chromosomes is equivalent to that of a 10 per cent solution of nucleic acid. Elsewhere (p. 33) he shows that a solution of this concentration absorbs 90 per cent of the incident light, whereas a protein layer (serum albumin) in the same concentration and under the same conditions absorbs only 2 per cent. It is clear from this that a concentration of protein equal to that of the supposed nucleic acid in the chromosome would have a negligible effect on the final curve. Yet in Caspersson's chromosome curve the protein so dominates the absorption that the maximum appears at a wave-length of

2750 A., which is characteristic of tryptophane, rather than at 2600 A., which is characteristic of nucleic acid.

It is evident that the application of ultra-violet spectrophotometry to structures such as nuclei in which the components are of unknown composition and are present in unknown concentration can give no certain information regarding the chemical nature of those structures. It follows, further, that the view that chromosomes consist mainly of nucleic acid and contain protein in a concentration "welche in keiner Weise mit der der Nukleinsäure vergleichbar ist" cannot be sustained. No doubt as knowledge of the chemistry of the nuclear constituents increases it will be possible to interpret some, if not all, of Caspersson's measurements. Until then, it would be rash to accept the many speculations which have been based upon his work, particularly those involving the postulated presence of ribose nucleic acid in the nucleoli.

Caspersson asserts that Norberg's analyses of Chironomus chromosomes are not to be regarded as preliminary ones. If we mistook the meaning of Norberg's apparently ambiguous statement on this subject, we can only plead that we were unconsciously influenced by the nature of the results themselves. Most of the analyses were carried out on chromosome balls, which obviously consisted of the chromosomes plus the bulk, if not all, of the nuclear sap. The main series of experiments gave values varying from 0·11 to $0{\cdot}48 \times 10^{-3}$ γ P. Thus, the maximum value obtained was more than four times the minimum one. We quite appreciate the difficulties of carrying out such experiments, but surely results of this nature should not be offered as confirmation of other work.

We do not propose to discuss further the question of the distribution of nucleic acid in the nucleus. Our position has been adequately stated in our previous communication[6] and we see no reason to change the views there expressed.

EDGAR STEDMAN.
ELLEN STEDMAN.

University of Edinburgh.
March 15.

[1] Darlington, C. D., NATURE, 149, 66 (1942).
[2] Miescher, F., "Die histochemischen und physiologischen Arbeiten" (Leipzig, 1897).
[3] Stedman, E., and Stedman, E, NATURE, 152, 267 (1943).
[4] Steudel, H., and Peiser, E., *Z. physiol. Chem*, 122, 298 (1922).
[5] Stedman, E., and Stedman, E., NATURE, 152, 556 (1943).
[6] Stedman, E., and Stedman, E., NATURE, 152, 504 (1943).
[7] Choudhuri, H. C., NATURE, 152, 475 (1943).
[8] Mathews, A. P., in Cowdry, E. V., "General Cytology" (Chicago, 1924).
[9] Caspersson, T, *Skand. Archiv. Physiol.*, Suppl. 8 (1936).

SCIENCE AND TECHNOLOGY IN THE POST-WAR WORLD

THE address entitled "The Promise of Technology" which Dr. F. B. Jewett delivered in the second series of conferences on "Post-war Goals and Economic Reconstruction", held under the auspices of the Institute on Post-war Reconstruction of New York University (*Science*, 99, 1–6 ; 1944), covers a number of points of high significance in the discussions at present proceeding in Great Britain with regard to the encouragement and endowment of fundamental research and the supply of research workers. Dr. Jewett, who is a vice-president of the American Telephone and Telegraph Co., points out that the technologist in the biological sciences during war-time is generally continuing in a different sector, on an enlarged scale and with clinical facilities not available in peace-time, the normal course of everyday life, and that most of what he has learned will be immediately applicable to peace-time. On the other hand, much of the technological applications of the physical sciences in war has no prospective application in peace-time. Dr. Jewett states that technology is the application of fundamental scientific discoveries and the employment of scientific methods for useful or desirable purposes ; except incidentally, technology as such is not concerned in the production of new implements of knowledge.

Normally, the scientific and technical world is divided roughly into two main groups : those concerned primarily with extending the boundaries of knowledge, developing new facts and learning more accurately the characteristics of old ones, without regard to their possible ultimate utility ; and those concerned in finding ways and means for the more effective application of fundamental science to the uses of mankind. As an integral part of its work, the first group has also the continuous production of new investigators for fundamental science and the training of men and women for industrial research.

Fundamental research, Dr. Jewett points out, flourishes best when there is complete freedom of intercourse and discussion and publication of results among the scientific men of the world, not merely within a given nation. Under normal conditions, the *modus operandi* in the second group is similarly that of free intercourse and interchange of ideas. The interruption of intercourse in war, with the consequent tendency for men, whether in fundamental or applied science, to work in water-tight compartments, leads to unnecessary duplication of work and general handicaps. Taken with the interruption and discontinuance of much fundamental research during war-time because it has not apparent immediate bearing on the war effort, and the deflexion of prospective recruits for such research to war activities, we are likely in consequence to find ourselves at the end of the War with a frontier of fundamental knowledge little beyond that which existed at the outbreak of war, although somewhat different in aspect. Advances in war-time have represented essentially a more intense utilization of existing knowledge and application of established techniques, and not new knowledge or technique itself. By and large, Dr. Jewett considers that during the period of active warfare there is an almost complete stagnation in the fundamental sciences. In addition, he considers that we shall have a paucity of young men and women broadly acquainted with established knowledge and rigorously trained in scientific method, in spite of the immense number who have become skilled technicians in limited fields, and a population with some real understanding of science and technology.

The cessation of hostilities, Dr. Jewett considers, will see an immediate disintegration of the present machinery of science and technology. Scientific men will wish to resume the pursuit of new knowledge in a free intellectual world, while industrial research workers and technologists will seek to take up again their former investigations and to fill in the gaps made by the inroads of war and the forced laying aside of promising new applications. There will be a dearth of highly trained men for fundamental research for

general application, and a large number of men trained in specific applications.

Pointing out that the new and wider understanding of science and technology on the part of the population in general is likely to lead to government playing a bigger part in the development of science and technology than in the past, Dr. Jewett insists that the functions of a director of research are essentially to provide a proper atmosphere in which men with creative ideas can work freely; to map out the general fields in which progress appears to lie; and finally to weigh the results of research work with many other factors in deciding how to proceed.

A number of Dr. Jewett's points have already been made in the report of the Parliamentary and Scientific Committee on "Scientific Research and the Universities"; the picture in Britain is not likely to be very dissimilar from that in the United States. In spite of reference to the question of freedom of intercourse and discussion and publication of results in the House of Lords debate on scientific research and elsewhere, this aspect has as yet attracted little attention, although there are signs of a more generous attitude towards publication on the part of industrialists. In that respect, however, apart altogether from the inevitable restrictions imposed by the War, British industry has lagged far behind industry in the United States. Dr. Jewett's address is to be welcomed on that ground alone—that it emphasizes once more the vital importance of freedom of communication to all creative and fundamental scientific investigation. No post-war plans for stimulating research in industry or elsewhere will have their full effect unless they establish the conditions in which such intercourse has the maximum encouragement.

GEOPHYSICAL EXPLORATION IN CANADA AND THE UNITED STATES

Evidence concerning geological formations near the surface of the earth, and down to depths of, say, less than one mile, can be obtained by geologists by examining the strata immediately accessible at the surface, and by inference from known similar formations, by skilfully extrapolating down to the required depth. When this process becomes somewhat risky and the formations are economically important, the sinking of boreholes at carefully selected critical places is then undertaken. These, however, are normally costly, and in their place, many companies have undertaken in recent years the geophysical surveys which, though less costly than the sinking of boreholes, have provided just that extra information which the geologist required, and that in reasonable time.

The geophysical methods of surveying may roughly be divided into four types, namely, the electrical, gravitational, magnetic and seismic, and in each of these, due to the large amount of experimental work done, great improvement in technique and in the consequent accuracy of the results has been achieved. The Rev. James B. Macelwane, *S.J.*, of St. Louis, has recently reviewed the work done in the United States and Canada during the years 1924–39 ("Fifteen Years of Geophysics: a Chapter in the Exploration of the United States and Canada, 1924–1939." By James B. Macelwane. *Geophysics*, 5, No. 3; July 1940).

Before 1924, according to the author, knowledge of geophysical methods of prospecting was not widely spread in America. In March of that year the Nash salt-dome was discovered by the torsion-balance method; in October the Orchard dome was discovered by the seismic method, and the Long Point dome by the torsion-balance and seismic methods. The current value of a new dome was between 500,000 and 1,000,000 dollars; so with the beginning of 1925, the use of the torsion-balance and seismic methods began to expand rapidly in America.

Seismic Methods. The years 1925–29 constitute the era of whirlwind seismic refraction reconnaissance. The mechanical seismographs gave place to electromagnetic seismographs, and the sound wave to precise surveying and radio signals. Up to 1929, according to Heiland, considerable areas had been explored in Alabama, California, Kansas, Louisiana, Mississippi, New Mexico, Oklahoma and Texas. Karcher, Eckhardt and McCollom had been experimenting with a reflexion seismograph, and it was at this stage that the Geophysical Research Corporation took the matter up and developed the modern multi-trace reflexion seismograph which has played so large a part in subsequent work. The seismic reflexion method has played an important part in this work of determining underground structure by means of artificial earthquakes since the year 1929.

In the United States of America the mid-continental area was the first to be surveyed in this way, and it was not until 1932 that this method was extensively used in the Texas-Louisiana Gulf Coast area. Now the seismic reflexion method is second only to the drill in the precision with which it is able to determine depths and outline structures. Secrecy is still maintained by some companies concerning the extent of this type of work undertaken by them.

Magnetic Methods. The magnetic method was in extensive use in North America from 1927 onwards. It is relatively inexpensive and the use of magnetometers simple, but so far as petroleum is concerned the magnetometer results are difficult to interpret with precision. Consequently, for petroleum surveys, the use of the magnetic method had largely ceased by 1931 for anything except preliminary surveys. In the mining field, however, its use has been practically continuous. Most of the central plains and coastal areas of the United States had been surveyed by this method up to 1939, and in Canada it had been used in the Provinces of Quebec, Ontario, New Brunswick, Nova Scotia and British Columbia.

Gravitational Methods. The two types of instruments used for these surveys are the torsion balance and the gravity meter. The torsion balance had excellent success in the Gulf Coast from the start in 1924; but it had reached its peak in 1931 and by 1937 was very little used in North America. Fieldworthy and sufficiently sensitive gravimeters were developed during 1937–38, and in the period immediately prior to the present War, field work with these was being conducted over extensive areas in the United States of America. According to Macelwane, so rapidly may these surveys be conducted, and so difficult and slow is the process of adequate interpretation of the data thus obtained, that there has accumulated in the files of most companies an undigested mass of differential or relative gravity values the meaning of which is not altogether clear.

Electrical Methods. These have proved most useful in the mining field. They were found to be inferior to the seismic and gravity methods in prospecting

for petroleum. Some of the electrical methods are used with geochemical prospecting because there would seem to be a connexion between certain electrical anomalies and geochemical prospects. By 1929, electrical surveys had been conducted in Alaska and sixteen States in America besides the Canadian Provinces of British Columbia, Manitoba, Nova Scotia, Ontario and Quebec, and in Newfoundland.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, April 22

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Dr. J. Blair Hartley: "The Future of Radiology in Obstetrics".

INSTITUTE OF PHYSICS (INDUSTRIAL RADIOLOGY GROUP) (at the Royal Institution, 21 Albemarle Street, Piccadilly, London, W.1), at 2.30 p.m.—Mr. W. H. Glaisher, Dr. W. Betteridge and Mr R. Eborall: "The Mottling of Aluminium Alloy Radiographs".

INSTITUTE OF PHYSICS (SCOTTISH BRANCH) (in the Chemistry Buildings, The University, Glasgow), at 2.30 p.m.—Inaugural Meeting. Mr. E. R. Davies: "High-Speed Photography, and its Applications in Science and Industry".*

Monday, April 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir A. H. Roy Fedden: "The Future of Commercial Aviation" (Cantor Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Fuel and Mechanical Power" (to be opened by Mr. J. F. Field).

Tuesday, April 25

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. A. P. van der Post. "Secondary Industries in South Africa".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Mr. David M. Fulcomer: "Bereavement as a Field for Research; an Introduction with Special Reference to Recent Research on Bereaved Spouses".

Wednesday, April 26

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. G. Samuel. "Some General Aspects of Potato Production in Great Britain"

PHYSICAL SOCIETY (at the Royal Institution, 21 Albemarle Street, London, W.1), at 5 p.m.—Prof. Joel H. Hildebrand: "The Liquid State" (Twenty-eighth Guthrie Lecture).

Thursday, April 27

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Prof. E. C. Stoner, F.R.S.: "Magnetism in Theory and Practice" (Thirty-fifth Kelvin Lecture).

BRITISH INSTITUTION OF RADIO ENGINEERS (LONDON SECTION) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Mr. P. Adorjan: "Development of Wired Broadcasting"

Saturday, April 29

BRITISH RHEOLOGISTS' CLUB (at the Shirley Institute, Didsbury, Manchester), at 10 a.m.—Discussion on "Elastic Behaviour of Textile Materials".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—"Photography as a Tool in Agriculture" (Papers will be read by Dr. E. N. Crook and Mr. V. Stansfield, and by a Representative of the National Institute of Agricultural Engineering).

PHYSICAL SOCIETY (at the new Clarendon Laboratory, Oxford), at 2.30 p.m.—Prof. Joel H. Hildebrand: "The Liquid State" (Twenty-eighth Guthrie Lecture).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT MASTER to teach ELECTRICAL ENGINEERING to Ordinary National Certificate standard in the Openshaw Technical School—The Director of Education, Education Office, Deansgate, Manchester (April 28).

LECTURER (temporary) in the PHYSICS DEPARTMENT—The Principal, Heriot-Watt College, Edinburgh (April 28).

LECTURER (full-time) IN CHEMISTRY—The Principal, Acton Technical College, High Street, London, W.3 (April 29).

PSYCHIATRIC SOCIAL WORKER to work with the Psychiatrist and Educational Psychologist in the Child Guidance Clinic—The Director of Education, Education Office, Town Hall, Barnsley (April 29).

RESEARCH METALLURGIST, preferably with knowledge of ENGINEERING, by well-known North Country firm specializing in the Use and Heat Treatment of High-Carbon and Alloy Steels—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2019XA) (April 29).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

EDUCATIONAL PSYCHOLOGIST, and a PSYCHIATRIST SOCIAL WORKER—The Secretary for Education, County Education Offices, Northampton (May 1)

LECTURER (full-time) IN CHEMISTRY at the Cardiff Technical College—The Director of Education, Education Offices, Cardiff (May 1).

CHAIR OF PHILOSOPHY at the University of the Witwatersrand, Johannesburg—Dr. William Cullen, 4 Broad Street Place, London, E.C.2 (May 1).

ENGINEERING WORKSHOP INSTRUCTOR in the Mechanical Engineering Department, a TEACHER OF SCIENCE AND MATHEMATICS, and a TEACHER OF WOODWORK, BUILDING CONSTRUCTION AND GEOMETRY, in the Junior Technical School of the Barnsley Mining and Technical College—The Principal, Technical College, Church Street, Barnsley (May 1).

LECTURER IN ORGANIC CHEMISTRY in the Brighton Technical College—The Education Officer, 54 Old Steine, Brighton (May 4)

VICE-PRINCIPAL of the Brighton Technical College (the post will be embodied with that of Head of the Civil Engineering and Building Department)—The Education Officer, 54 Old Steine, Brighton (May 4)

DISTRICT ENGINEER by the Ceylon Government Railway—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.926A) (May 10)

SENIOR POST under the AERONAUTICAL INSPECTION DIRECTORATE (applicants should possess a first-class Honours Degree in Physics or a recognized equivalent, have had industrial radiological experience, be conversant with the various modifications of the technique of X-ray crystal analysis, and be capable of carrying out independent *ad hoc* scientific investigations in electro-physics)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.499A) (May 10)

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

TEACHER (full-time) in the MATHEMATICS AND PHYSICS DEPARTMENT—The Principal, Municipal Technical College, Hopwood Lane, Halifax

MEN qualified to teach MATHEMATICS, SCIENCE and MACHINE DRAWING, at the Wakefield Technical College—The Director of Education, 27 King Street, Wakefield.

GRADUATE ASSISTANT (temporary) with special qualifications in MECHANICAL ENGINEERING, a GRADUATE ASSISTANT (temporary) with First- or Second-Class Honours or Higher Degree in either MATHEMATICS or PHYSICS, and a well-qualified ASSISTANT (temporary) with trade experience for ENGINEERING WORKSHOP PRACTICE—The Principal, Mining and Technical Institute, Neath, Glam.

PRINCIPAL OF THE ROYAL HOLLOWAY COLLEGE—The Secretary to the Governors, Royal Holloway College, Englefield Green, Surrey

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Medical Research Council. War Memorandum No. 11: The Control of Cross Infection in Hospitals. Pp. 34. (London: H.M. Stationery Office.) 6*d*. net. [213

South-West Essex Technical College and School of Art Annual Report, Session 1942–43. Pp. 32+2 plates. (London: South-West Essex Technical College and School of Art, Walthamstow.) [223

Geological Survey of Great Britain. Scotland. War-time Pamphlet No. 13: Limestones of Scotland, Area 1: Southern Scotland. By Dr. J. B. Simpson: with Analyses by Dr. A. Muir and H. G. M. Hardie. Pp. 24. (London: Geological Survey and Museum.) 1*s*. 3*d*. [223

Medical Research Council. War Memorandum No. 12: The Use of Penicillin in treating War Wounds. (Instructions prepared by the Penicillin Clinical Trials Committee.) Pp. 16. (London: H.M. Stationery Office.) 3*d*. net. [243

Other Countries

League of Nations: Economic, Financial and Transit Department. Agricultural Production in Continental Europe during the 1914–18 War and the Reconstruction Period. (Publication 1943, II.A.7.) Pp. 122. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 7*s*. 6*d*. [203

League of Nations. Report on the Work of the League, 1942–1943, submitted by the Acting Secretary-General. (Publication, General, 1943,1.) Pp. 117. (Geneva: League of Nations; London: George Allen and Unwin, Ltd.) 2*s*. [23

Report on the Operations of the Department of Agriculture, Burma, for the Years 1941–42 and 1942–43. Pp. 26. (Simla: Department of Agriculture, Burma.) [273

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 169: The Entomological Control of St. John's Wort (*Hypericum perforatum* L.), with particular reference to the Insect Enemies of the Weed in Southern France. By Frank Wilson. Pp. 87. Bulletin No. 171: Experiments with Insecticides against the Red-legged Earth Mite (*Halotydeus destructor* (Tucker)). By K. R. Norris. Pp. 28. (Melbourne: Government Printer.) [273

Association of Scientific Workers of Southern Africa. Research Memorandum 2: Considerations for Planning Farming in South Africa. Pp. 22. 1*s*. 6*d*. Research Memorandum 3: The Native Reserves and Post-War Reconstruction. By Edward R. Roux. Pp. 12. 6*d*. (Cape Town: Association of Scientific Workers of Southern Africa.) [303

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LOCATION OF INDUSTRY AND PROVISION OF MAN-POWER

THE memorandum, "Considerations Affecting Post-War Employment in the North-East", which has been issued by the Northern Industrial Group, consisting of employers and trade-union leaders in northern England, and which has been sent to the Minister of Reconstruction, is not only of interest in relation to post-war reconstruction and employment policy and the change from a war to a peace economy. It may well be compared with the report submitted in May 1935 to the District Commissioner for Depressed Areas by a joint committee of the local sections of the Society of Chemical Industry, the Royal Institute of Chemistry and the Chemical Society, and with a subsequent report, "The Industrial Position of the North-East Coast of England", issued later in the same year by the staff of the Economics Department of Armstrong College, Newcastle on Tyne. The conclusions reached in the latter report appear to be fully confirmed and to be as valid to-day as eight years ago, and substantially the same is true of the other report and especially of the section contributed by the sub-committee on science and industry.

The Northern Industrial Group in its memorandum points out that the War has brought no real change to the industrial structure in the area. That structure remains much as it was in the days of the depression ; and unless adequate preventive measures are taken there is real danger that the employment and standard of living of people in the area will again be seriously threatened after the present War. Still more disturbing, not to say disappointing, is the absence in this memorandum of any real evidence that the lessons set forth so clearly in the reports from Armstrong College and the joint committee of the chemical societies have been learnt, or of the extensive application of scientific methods to those industries which situation and local raw materials make possible. Something more than vigorous action on the part of the central Government still appears to be required to eliminate the threat of large-scale unemployment in the area ; and while responsibility for the position cannot fairly be laid entirely on the industrial leaders of the area, they have yet to clear themselves of the charge of absence of foresight and neglect of science brought against them eight years ago.

There are other respects in which the general situation has changed ; but the indictment in the earlier reports needs to be kept in mind the more because of the shift in emphasis from local to national responsibility, which has been accentuated in the interval. It is now widely recognized, and rightly, that certain basic decisions as to policy must be made by the central Government before local authorities or even regional authorities can act wisely or effectively. The memorandum of the Northern Industrial Group assumes first, for example, that a national economic policy will be adopted, and that to secure ample employment in reparation and reconstruction work at home and abroad the Government

will continue to control production in some way for an interim period of unknown length after the War, with a gradual change to a peace-time economy. In this interim period, any deficiencies in employment in Great Britain should be met by work on the many necessary schemes for public works. National policy should also assure a stable level of employment in the heavy industries and in agriculture.

Even with such measures, on the basis of the immediate pre-war industrial structure of the region, there will be a surplus of some 130,000 persons for whom employment will have to be found, and such estimates of the post-war capacity of the heavy industries in the area as the Group is able to make suggest that new forms of occupation will be required for more than 100,000 people, even without allowing for women seeking employment. The Group, however, firmly rejects the large-scale transfer of population from the north-east of England to other areas as socially and economically undesirable; although there is nothing in the memorandum to indicate dissent from the view implicit in the Beveridge Report that greater mobility of labour generally is desirable, if not essential. The memorandum holds that the future policy should be to employ people in their own surroundings. The Group believes that the north-east of England has its own background and a tradition of virility and of independence which is an asset to the nation and should be preserved. Social security may, in fact, increasingly necessitate the adjustment of employment to the distribution of population.

Such considerations lead to the conclusion that the solution of the industrial problem of the north-east of England lies in the development in the area of a much greater variety of industries making highly developed products suitable for export as well as for the home market. Such a development would mitigate a permanent change in employment by heavy industry and provide a reserve of employment to meet fluctuations. In particular, further developments in the area of the processing of coal to oil, plastics, etc., are recommended, and the memorandum urges that whatever emerges as part of Great Britain's fuel policy from experimental work now in progress should be concentrated in this and other coal-producing regions. Again, certain parts of the area should be cleared of derelict buildings to encourage development, and any further capacity required for war production should be located in the area. After the War, an active policy of building factories in the area to make up for the effects of war development should be prosecuted, with the transfer of factories rather than labour.

All this, and the continuance of the measures adopted before the War to bring light industries to the north-east of England, involves a national policy for the location of industry, and the memorandum once more directs attention to the necessity for implementing the recommendations of the Barlow Commission. The reference to this question which Lord Woolton made in his recent statement shows that the Government is already giving some attention to the problem of structural unemployment, and Lord Woolton suggested that the Government might use the disposition of State factories to assist the creation of a diversity of industries in areas such as the north-east coast. Mr. Dalton had already broached the idea that such factories might become the nucleus of new trading estates, and it may be that the Government is giving more attention to the location of industry than has appeared in its pronouncements.

Other recommendations in this memorandum touching on the same question are the consideration of freight rates and their effect on the location of new industries, the provision of national finance for the local reorganization of housing and industry in certain areas such as part of south-west Durham, amendment of housing legislation to allow of more flexibility and a closer co-ordination with industrial policy and the provision of additional trading estate facilities in the area. Once again the multiplicity of local authorities, particularly on Tyneside, and the limitations of the rating system, with the consequent encouragement of sectional and parochial views, receive strong comment, and here again it is urged that the areas of local authorities should be re-drawn to give larger and more effective units. In this the memorandum is clearly alive to the importance of maintaining local interest, attracting industry to take a larger share of this form of public service, and giving the local authorities wider and more effective scope for co-operation with the industrial community as a whole; its final recommendation is the formation of a local development organization to continue the study of these problems, to co-ordinate them and keep them before the attention of the Government, utilizing the experience of the pre-war North-East Development Board and subsequent experience.

The memorandum clearly fits into the pattern of post-war employment policies which was covered broadly by Lord Woolton's statement in the House of Lords on February 15. Like that statement, it visualizes the need for some measure of Government control at least during the first two of the three economic phases through which we must pass during the immediate post-war years, and of definite guidance if not control during the third phase. Once again it emphasizes the necessity for Government decision and the elaboration of a policy in regard to such matters as the location of industry, before either particular industries or regions can proceed to elaborate their own plans. Furthermore, any such plans must be related to a national policy and plan, and clear guidance must be given as to the principles on which national and regional plans are to be based. Only then, and when some real attention has been given to the way in which such developments will react on the position and resources of local authorities and their relation to the central Government, can a practical scheme and time-table of demobilization be worked out and explained to those concerned.

Lord Woolton's own statement was admittedly incomplete, for it disregarded the international aspects of employment policy, control of raw materials, trade and currency policy. None the less, the ground he covered, leaving out of account the Service ministries that will be concerned with demobilization, relates to policy which must come under at least six depart-

ments—the Treasury, the Board of Trade, and the Ministries of Production, Supply, Aircraft Production and Labour, apart altogether from the authorities concerned with building and physical reconstruction. The impossibility of fitting departmental policy and measures together, without the prior and clear enunciation of the main lines and principles of policy at the centre, in a way that will solve the long-term employment problem, and permit a smooth transition from a war to a peace economy could scarcely be demonstrated better. Nor can even the essential task of educating public opinion as to what is involved proceed until policy has thus been enunciated.

The necessity for such publicity is well brought out in an able analysis of the whole question of demobilization and employment, which frankly faces the general question of the depressed areas, contained in a broadsheet (No. 217) recently issued by Political and Economic Planning. The problems which will confront us in remobilizing for peace are examined in the light of the experience of the War of 1914–18, and while the necessity of striking a balance between economic needs and the desires of service men is recognized, the imperative necessity of a publicity campaign, planned with all the vision and skill at the Government's command, to explain the why and how of policy, is equally stressed. No scheme will avoid all difficulties, but if the situation is fairly and simply explained to the millions of service men and war workers, it would do much to temper impatience and to curb over-sanguine expectations.

The preliminary analysis in the broadsheet follows the lines of Lord Woolton's statement. For several years the demand for man-power will far exceed the supply; quite apart from war requirements in the Far East, massive dammed-up demands for peace-time goods will place a heavy load on industry for some time to come. Inflation rather than general unemployment will be the danger. Social equity and economic order alike will require a system of priorities, and these must be carefully balanced to ensure that demands are in harmony with industrial capacity.

Dealing first with military demobilization and viewing it as a part of the vast business of re-orientating the war economy, the broadsheet points out that military factors will determine the rate of discharge. With regard to the question whether the rate of discharge should be left simply to military considerations or further controlled by the availability of jobs, the broadsheet quotes with approval the official view that the rate should be governed solely by operational requirements. The principles governing the order of release are likely to give far more difficulty, and here the wisdom of public announcement by the military authorities at an early date of the general principles they propose to adopt, and the strict observance of the principles formulated, are of paramount importance. The first rational principle is that industry's needs should be paramount: the speed with which the wheels of peace-time industry can be restarted will depend in part on the availability of certain key men. Some enterprises will be unable to revive quickly unless they are able to obtain the services of skilled men now in the Armed Forces. To make personal and family status the only test might quickly lead to chaos. Some account must be taken of the industrial background at home, though none the less policy must be affected by what service men will regard as fair.

The essential proposals of the report on demobilization issued by the Liberal Party Committee are in striking harmony with many of the views of P E P. The features of the Liberal Party's report are the emphasis placed on the need for speed in carrying out demobilization, and the insistence on the improvement of conditions of pay and service in the Armed Forces so that it may be possible to recruit without delay a professional army for the maintenance of order abroad. The report urges that it is the negation of both democracy and justice to retain the principle of compulsion in relation to military service merely to avoid the introduction of adequate scales of pay.

Plans for re-settlement in civil life are of capital importance in any demobilization scheme, and this report and the broadsheet both stress the necessity for opportunities for re-training and education. The report would make the continued receipt of pay and allowances, and certainly of unemployment benefit, after the first three months, conditional on attendance at training centres by those who had been unable to obtain civilian employment, while the broadsheet urges a serious effort to mobilize as many teachers as possible for this purpose. The Government plans are welcomed, especially the appointment of the strong committee under Lord Hankey to advise the Appointments Department of the Ministry of Labour. The debates on the Reinstatement in Employment Bill have made it plain that reinstatement is only part of a bigger problem. The crux of the matter is to ensure employment, and the broadsheet, in discussing what may be termed the reception end, suggests that the employment exchanges must be made both more efficient and more acceptable to employers and employees alike than they were before the War. It is also suggested that the exchanges might draw on Army experience with intelligence and aptitude tests for fitting the right man to the right job, and take over some of the trained Army personnel. Records which have been accumulated by the Services should be made available to the exchanges, so that they have information not only about a man's technical training and service experience but also about his general aptitudes.

Turning then to the question of industrial employment, the P E P broadsheet has no hesitation in assuming that a high demand for labour will continue. Apart from the military demands for the War in the Far East, production in general may not slacken nearly so much as many people think; there will be a vast demand waiting to be satisfied in the civilian field, and there will be keen competition to utilize any resources which may be released from the war effort. Export, for example, must rank as a high priority. It is of the first importance that Britain should not let domestic demands so swamp productive capacity that export markets are lost by default. Consumers will also wish to make good the accumulated deficiencies of war-time, and there will be the more

serious deficiencies in the nation's capital equipment to make good, notably in building; finally, Britain will have to bear her share of the cost of relief for the great areas of the world which have been devastated or impoverished by the Nazis or the Japanese.

The great problem in the view of P E P will be how to secure enough labour for the jobs that will need doing—for continued military production, for exports, for housing, for the manufacture of consumers' goods for relief. Accordingly, it will be essential for the Ministry of Labour to retain its powers under the Essential Work Orders. As a consequence of the prevailing shortage, the labour factor will continue to be of high importance in the general economic strategy, and the position of the Ministry of Labour as pivotal as it has become in the later stages of the War.

Two provisos are made to the general proposition that there will be a shortage of labour for some years after the end of hostilities in Europe. First, as already indicated, some temporary unemployment due to the transition from one type of production to another, and from war to peace production, is inevitable. Secondly, employment opportunities will not necessarily be distributed in accordance with the supply of labour. There may be pockets of unemployment, and the Northern Industrial Group in its memorandum directs attention to this outstanding danger which may threaten other areas besides the north-east coast of England.

P E P urges that it should be one of the great aims of Government policy to encourage industrial development in these areas. The end of the War should provide a great opportunity to establish in the former Depressed Areas new enterprises giving a better balance between foreign and home markets, and between light and heavy industries. The Government's many powerful instruments of control place it in a strong position to prevent local unemployment either in the short or in the long run. As the chief customer for most of the country's industry, the Government will possess in the process of terminating its contracts a strong lever which could be used to minimize or prevent local unemployment. The disposition of plant and equipment owned by the State and the power to license materials could all be used to prevent local unemployment, for example, by implementing trading estates, new centres of light industry and developing new processes and raw materials, as the president of the Board of Trade has already indicated.

Despite the complexity of the problems involved in military demobilization and industrial re-adjustment, there is therefore no reason for pessimism as to the employment situation in Great Britain; there should be little danger of general, though there will be some danger of local, unemployment. The process of adjustment can, however, only be made tolerable by planning, and by the retention of some at least of the measures of war-time control. If that is to succeed, the reasons for planning and control must be made plain to all, and their purpose clearly and honestly explained. That is as essential as it is that the Government should make its decisions and announce its central policy as early as possible, so that regional and local action is possible in harmony with the national plan, and as large a measure of initiative and freedom afforded to local enterprise as is consistent with orderly transition from war to peace.

JUDGMENT ON PLANNING

T V A

Adventure in Planning. By Prof. Julian Huxley. Pp. 142. (Cheam: Architectural Press, Ltd., 1943.) 8*s*. 6*d*.

THE Tennessee Valley Authority has now been established for ten years, and the experience of a full decade renders possible an attempt to assess its achievements and their significance, both in relation to the problems of regional planning in Great Britain and to the no less difficult range of administrative problems involved in public control and the relations between local and central government. In giving us the first detailed account published in Great Britain of this achievement, Dr. Huxley provides an admirable complement to Prof. C. Herman Pritchett's "The Tennessee Valley Authority: a Study in Public Administration", copies of which only now appear to have reached this country, although it was published in the United States in 1942.

Prof. Pritchett's book, as its sub-title indicates, is in the sequence of Prof. R. E. Cushman's study "The Independent Regulatory Commissions", from which consideration of the Tennessee Valley Authority was expressly excluded. It is concerned essentially with the political and administrative problems of the venture and makes a striking appendix to the report of the President's Committee on Administrative Management. Dr. Huxley, on the other hand, while not ignoring those aspects, places his main stress on the social and broader technical aspects of what he rightly terms an experiment or adventure in planning. His able presentation of the whole range of problems, and his skilful and lucid delineation of the fundamental questions or principles involved, coupled with the admirable photographs with which the book is illustrated and a good bibliography, should make his book as welcome to the serious student as to the general reader.

For the scientific worker, this account of the use of the scientific method of research, survey and experiment in dealing with great and complex social and economic problems is of special interest. Even those who have some knowledge of the achievements of the Tennessee Valley Authority in regard to power supply and to soil conservation may well be surprised at the picture Dr. Huxley gives of the effects of this great experiment on agriculture, health, labour, education, architecture and design. From the outset, the Authority has realized the enormous potential value of its reservoirs for recreation, and from this has proceeded to plan for the same development of all aspects of recreation in the Valley. No section of Dr. Huxley's book is more suggestive at the present time than that in which he describes the work of the Authority in regard to parks and wild life, and it deserves the close attention of all those concerned with present proposals for nature reserves or national parks in Britain.

Continuous research and survey are the essence of any large-scale planning, but many scientific workers will learn for the first time in these pages of

the wide range of research for which the Tennessee Valley Authority has been responsible in the ten years of its existence, apart altogether from its basic surveys of the mineral and agricultural resources of the Tennessee valley. Particularly is this true of its research at the consumer end, for example, on the design of agricultural machinery suited to the physical and economic peculiarities of the region; while Dr. Huxley's reference to the archæological investigation of the area to be flooded at the Pickwick Dam site, directed by the Authority in co-operation with the University of Alabama, makes a startling contrast with the way in which we have permitted quarrying to endanger the Roman Wall, to name only one recent example.

Dr. Huxley's account of the achievements of the Tennessee Valley Authority is the more impressive because he brings out the dangers or weaknesses as well as the advantages of regional planning on this scale. Compulsory powers, he points out, should never constitute more than the skeleton of planning. The living plan itself must evolve and grow, and can only do so on the basis of co-operative participation—both co-operation with other Government bodies and official and unofficial agencies, and co-operation with the people of the region, through arousing their sense of participation and making them feel that it is their plan and that they have a real share in bringing it to fruition.

It is for the way in which it has endeavoured, largely with success, to secure such co-operation that the Tennessee Valley Authority is of such prime importance in relation to post-war reconstruction. Its decentralized administration, as Dr. Huxley emphasizes, gives it a further claim to close study in this connexion and has contributed largely to its success. The way in which this has been achieved—by making the greatest number of decisions on the spot, by developing so far as possible the active participation of the people themselves, by co-ordinating in the field the work of all other agencies concerned, and by decentralizing the idea behind an administration so that its planning becomes a part of public opinion—has a vital bearing on those problems of centralization, regionalism and local control with which we are already being confronted in almost every one of the fields in which we are tentatively approaching the problems of the post-war world.

Dr. Huxley himself indicates the significance that this great experiment has for such war-time developments as the Middle East Supply Council or the Caribbean Commission, or for such suggestions as that for a post-war Danube Valley Authority. Readers of Dr. Huxley's book should be able to form some independent opinion as to how far Mr. Hugh Quigley is right in his contention in a recent article in *Agenda*, on "The Highlands of Scotland: Proposals for Development", that the riches of the Highland landscape, life and enterprise should be enjoyed as a national possession or in his suggestions for their preservation.

Dr. Huxley's book should stimulate much fresh thought about this and other problems of depressed areas and regionalism in Great Britain. Its topical bearing, no less than its admirable presentation, should ensure it a place on the shelves of all concerned with problems of reconstruction and regional planning, and the application of scientific method in the solution of social and economic problems.

R. Brightman.

THE SOCIOLOGY OF CRIME

Race and Crime

By Willem Adriaan Bonger. Translated from the Dutch by Margaret Mathews Hordyk. Pp. xi+130. (New York: Columbia University Press; London: Oxford University Press, 1943.) 10*s*. net.

From 1922 until his death in 1940, Willem Bonger was professor of sociology and criminology in the University of Amsterdam. To psychologists and criminologists he is best known from his "Introduction to Criminology", the outcome of his life's work. In that volume, as in his earlier contributions, he showed himself a keen and critical champion of the view that crime must be regarded as a social or psychological rather than as a medical or biological problem. This was in effect a revolt against the views of the 'anthropological school' of criminology, which, under the leadership of Lombroso and his Italian followers, still dominated the psychology of crime when Bonger first began to write. His last book, on "Race and Crime", deals with what he terms the 'neo-Lombrosian theory'. Mrs. Hordyk received the manuscript only a few days before Holland was invaded, and has produced a most competent and welcome translation.

Dr. Bonger begins by pointing out the highly unscientific way in which the term 'race' has been used, even by anthropologists of repute. An adequate definition, he maintains, ought to imply, not only that the members of the race possess a number of physical and mental characteristics in common, but also that these common characteristics are inherited. Language, the chief criterion of older writers, is not inheritable; and the physical characteristics by which recent anthropologists have attempted to distinguish existing 'races' are in his view "comparatively superficial", and can be but remotely connected with differences in mind or conduct. Moreover, as he observes, when races intermarry, their physical characteristics, such as the determinants of hair and eye colour, may frequently fail to blend; but mental characteristics almost invariably show blending, with a 'normal' rather than a bimodal distribution. Hence groups that may appear to be racially pure when judged by physical criteria may, in point of fact, prove to be highly intermingled when we compare their innate traits of intelligence and temperament. Above all, whether innate or not, "in the psychological sphere, individual differences between members of the same race are so great that differences between races themselves are by comparison small".

The bulk of his book consists in an analysis of recent criminal statistics collected from various countries, and classified according to presumable racial origins. In Europe, for example, during 1927–32, the number of persons convicted of murder and manslaughter per 100,000 of the adult population varied enormously in different countries—from 0·2 in England and Norway to 22·3 in Bulgaria. Broadly speaking, the frequency of such crimes appears lowest in the north-west (though Ireland is a minor exception), somewhat higher in the central areas, higher still in the south, and highest of all in the Balkan and east Baltic areas. At first sight this seems consistent with theories, like that put forward by Kurella and more recently maintained by Martin, to the effect that the Nordic races are freest from crime, the Alpine races nearly as free, the Mediterranean

races decidedly more prone, and the Slavs most liable of all. A more detailed examination, however, shows that, within each country, both the frequency and the nature of the crimes are far more closely related to historical, social, and economic differences than to racial: thus in remote agrarian districts, where material and cultural poverty prevails, crimes against property as well as persons are comparatively common, regardless of racial or national differences; again, in countries where until recently semi-feudal conditions obtained, and particularly where the tradition of private vendetta has survived, homicide is by no means infrequent. The Jewish record for theft, for sexual misdemeanours, and for every type of serious aggressive crime, is everywhere remarkably favourable; on the other hand, commercial crimes are about half as common again among Jews as among other inhabitants of the same country in question. Yet once again these differences are chiefly due to records from urban and commercial areas; and, when local variations are more closely studied, it appears that the offences of the Jews show a marked inclination towards those typical of the areas in which the different Jewish communities are found.

Among immigrants to the United States, the figures for different nationalities at first sight show a general correspondence with those reported from their respective home countries. But this holds true only of the first generation or two: thus, among children of Italian parents who were themselves both born in America, the figures drop practically to the level of native Americans. For Negroes the proportions are nearly three or four times as high as they are for whites; yet, as Dr. Bonger shows by detailed quotation, most American criminologists are agreed that the social and economic conditions under which the Negroes live go far to offer an explanation of the facts observed.

From these and other statistical data, Dr. Bonger finally concludes that differences in racial intelligence and temperament cannot be wholly excluded; but he considers that their influence is remote, indirect, and "sorely exaggerated". Crime, as such, is not inheritable. But there is reason for believing that it "proceeds from instincts common to all men", and that different races may inherit those instincts with differing intensity. Accordingly, although such minor differences in instinctive propensities "have in themselves no necessary connection with crime, still, in certain social circumstances", he holds, "they might impart a stronger anti-social bias to certain members of the population". CYRIL BURT.

FAT METABOLISM

The Metabolism of Fat

(Monographs on Biological Subjects.) By Dr. Ida Smedley-Maclean. Pp. vi+104. (London: Methuen and Co., Ltd., 1943.) 5*s*. net.

THERE is a considerable lack of comprehensive up-to-date monographs on biochemical topics, and especially on fat metabolism. The present book was intended to fill this gap in the field of fat biochemistry and to provide students, especially those with little or no previous knowledge of the subject, with a short account of the present-day knowledge on fat metabolism. The author deals briefly in seven chapters with the synthesis of fatty acids, the constitution and the role of the unsaturated fatty acids in the organism, the oxidation of fatty acids *in vitro* and *in vivo*, the constitution of lipoids and the transport of fatty acids in the animal body. A list of references and a short subject index conclude the book.

The author was aware of the impossibility of giving a complete survey of the field in so short a space, and has succeeded in many respects in giving a clear picture of the broad outlines of our knowledge on the subject. In a number of instances, however, the highly controversial and far from complete picture of fat metabolism is over-simplified and the gaps in our knowledge are filled with a disproportionately long account of current theories. Thus, for example, the views on the possible mechanism of fatty acid synthesis are expounded at some length, which no doubt gives the reader a simple view of the subject, but one little supported by experimental evidence. Also the treatment of the subject of oxidation of fatty acids does not give a balanced view of the experimental evidence and the numerous theories. In the chapter on fat transport in the animal body considerable stress is laid on the theory of Verzar, although many of his results have not been confirmed by other workers.

There are a few errors in chemical formulæ (pp. 78, 79) and in the indexing of references.

A. KLEINZELLER.

ELECTRONIC THEORY IN CHEMISTRY

Electronic Theory and Chemical Reactions

An Elementary Treatment. By R. W. Stott. Pp. viii+112. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1943.) 6*s*. net.

IN the last two decades, the interpretation of reaction mechanism from the point of view of the electronic theory of valency has advanced apace, and the rapid growth of the original literature on the subject has made it difficult for those not primarily engaged in its furtherance to keep abreast of the developments. To some extent this difficulty has recently been met by the appearance of a number of summarizing articles and a few books. In the booklet under review we have the latest addition to this collection.

In six short chapters entitled "Inorganic Compounds", "Organic Acids and Reactive Hydrogen Atoms", "The Mechanisms of Certain Types of Reactions of Organic Compounds", "The Structure of Benzene and other Aromatic Compounds", "Substitution in the Benzene Nucleus", and "Some Uses of Radio-active and other Isotopes", the author attempts to give a brief sketch of the theory of chemical reactions. This is a formidable task, but, though the treatment is in parts somewhat over-simplified, and is not free from errors, the book will undoubtedly be found useful as an elementary introduction to the subject. It is intended mainly for the use of first-year students, for others who have but limited time for reading, and, possibly, for advanced sixth-form pupils. In his preface the author writes: "If this book stimulates interest in what is an attractive subject, and encourages further reading and investigation, it will have fulfilled the purpose for which it has been written". It is the reviewer's opinion that the book will achieve this object.

E. D. HUGHES.

NEOLITHIC FOREST CLEARANCE

By Dr. H. GODWIN
Botany School, Cambridge

IT is the first approximation of the ecologist to relate the control of distribution of major vegetational types to major climatic types : only later does he advance to consider how human activities have interfered with and complicated the pattern determined in the first place by climate. The same relationship has held for the study of palæo-ecology by the methods of pollen-analysis. We have firmly established the general picture of forest movement across north-west Europe under the compulsion of changing climate, and now comes the phase when for the first time we seek to recognize, by pollen-analysis, the rôle of prehistoric man in changing the natural forest cover of Europe. We are brought to recognize this new phase by a recent publication of Johs. Iverson in the series of the Danish Geological Survey*, on "Land Occupation in Denmark's Stone Age".

Iverson begins with the thesis that Palæolithic and Mesolithic men were hunters and fishers, who modified very little the natural vegetation of the lands they so sparsely occupied, and indeed the application of the term 'forest culture' to the Mesolithic implies that the forest dominated man, and not the other way round. With the introduction of farmer culture to Denmark by the invasion of Neolithic man this state of affairs was radically altered, and Iverson seeks and finds evidence for this change in a striking series of pollen investigations. The dating of this change to the Neolithic period can sometimes be directly established ; but more often it can be recognized from the pollen diagrams themselves. It is already well known that the Neolithic in Denmark falls in the middle of the oak-forest period in which oak, elm, and the linden together formed the high forest, with alder and birch in the wetter places and pine and birch in the drier. Iverson points out that pollen of the Ulmus (elm) in the middle of the oak period shows a conspicuous and consistent fall from uniform high to uniform low values. He has, by very laborious counts, shown that the far less frequent pollen of the ivy (*Hedera helix*) shows a very similar decrease at the same time, while the pollen of ash (Fraxinus) increases. This diminution in abundance of such a strongly Atlantic species as the ivy is considered by him to indicate the climatic change from the so-called 'Atlantic' to the 'Sub-boreal' period, a change agreed to fall very near the opening of the Neolithic in this part of Europe. There is no doubt that the fossil elm pollen in Britain gives every sign of coming from a tree with preference for an oceanic climate, and the sudden diminution of its frequency has been already recognized here, as in other parts of north-western Europe, as a trustworthy horizon.

Iverson now points out that in many Danish pollen diagrams, just above this clear climatically determined horizon, the pollen curves indicate a very sudden and peculiar change in forest composition. This is perhaps best shown at Ordrup Mose, where a layer of charcoal stratified into the marginal nekronmuds of a former lake give evidence of burning, and thus perhaps, indirectly, of human occupation. At this level the elements of the high forest, Quercus, Tilia, Fraxinus and Ulmus, undergo a distinct but temporary decline, while Betula reveals a transitory, Alnus a more lasting increase, in pollen frequency, and at the same time the Corylus (hazel) curve reaches a very pronounced maximum. Iverson assumes that these pollen-floristic changes "express the vegetational developments in a region where land-tilling people have occupied the land and cleared this dense primeval forest with axe and fire". The decline of the high forest tree-pollen curves is due to local destruction; the rise of birch, alder and hazel afterwards is due to the rapid regeneration of these species in cleared areas, partly from stumps and partly by their seeds, which, especially in birch and alder, facilitate quick dispersal.

This interpretation receives support from several directions. First is the actual charcoal layer at Ordrup. Second is the fact that at this level the *absolute* tree-pollen frequencies (per unit surface of prepared slide) fall suddenly to very low values and then slowly recover.

Thirdly, Iverson produces striking evidence from the examination of the non-tree pollen content of the lake deposits. Just above the charcoal layer the sum of the non-tree pollen increases suddenly just as one would expect by his hypothesis, but especial importance is attached to his identifications of the species contributing to this total. It had already been pointed out by Firbas that the pollen of cultivated cereals could in general be distinguished by its size and associated characters from that of other grasses, and Iverson shows that continuous though low amounts of cereal pollen are represented in the Ordrup profile above the level of sudden oak forest diminution. Along with this there begins a substantial and continuous curve for the pollen of Plantago, the common plantains, of the species *P. major* and *P. lanceolata*, which have always been very strongly associated with human disturbance of natural vegetation. In addition to this the pollen of Artemisia reaches high percentages, and Iverson suggests that this is probably due to *A. vulgaris*, which was a serious weed in Denmark until the practice of deep ploughing became possible. In several bogs of small size Iverson has been able to show the sudden minimum in the oak forest pollen curves, together with the associated rise of anthropochorus plants, forming an episode so "sudden and brief" in the pollen diagram that it can be taken as indicative of the vegetational succession after local occupation by man and only short-lived settlement. In the deposits of larger fiords or lakes the tree-pollen curves show less sudden disturbances, although the 'weed' and cereal pollen begin continuous curves at the usual level. It is reasonable to consider that pollen diagrams from such places reflect a generalized picture of a whole series of forest clearances over a large tract of countryside, and here, no doubt, it is much less easy to attribute the changes in pollen frequency to the single cause of human interference.

Iverson points out that when the initial phase of disturbance is past, the general forest composition shows little sign of permanent alteration until the beginning of the Early Iron Age. This constancy he is inclined to attribute to the type of forest exploitation practised by the Neolithic settlers, and he speculates that they may well have used the clearance fire to provide not only space for the cultivation of cereals, but also areas of rich herbaceous vegetation and tender tree and shrub shoots to serve for cattle grazing. It is recalled that similar employ-

* Landnam i Danmarks Stenalder (Land Occupation in Denmark's Stone Age). By Johs. Iverson. Danmarks Geologiske Undersøgelse II Række. No. 66. Pp. 68+9 plates. (Copenhagen, 1941.)

ment of clearance fires still continues in backward parts of Europe, and that the Danish archæologist G. Hatt had already indicated the probability that it was in use in prehistoric Denmark.

It follows naturally that if we accept the argument of Iverson thus far, we must expect to find that when the 'Sub-atlantic' climatic period began, no less important vegetational changes took place. For at this time not only the swift climatic 'deterioration' occurred, but also the establishment of a new people with iron implements and the permanent regular settlement associated with village culture. In fact, Iverson is able to demonstrate that the pollen diagrams and peat profiles do reflect such changes. There is the extensive water-logging of low-lying land and the formation of aquatic 'precursor' peat with *Scheuchzeria palustris* above the uniform and highly humified Sphagnum-Calluna peat of raised bogs, and there is the considerable extension of Fagus (beech) at the expense of Quercus (oak) in the pollen diagrams. Both these are climatic effects. In addition, there is a progressive forest destruction by human activity which is indicated by a further considerable increase in the pollen of herbaceous plants, and, in the heathy areas, by increase in the pollen of the ling, *Calluna vulgaris*. The pollen diagrams indicate that in the heath region of central Jutland it was not until the Early Iron Age that great and continuous areas of heath were formed, although some heath was doubtless produced by Neolithic and Bronze Age clearance, and even in Pre-neolithic times the woodlands were much more open than those on the heavier soils.

Iverson's most stimulating piece of research emphasizes what was already dimly recognized, that an *ecological* approach to the interpretation of the results of pollen-analysis is logical and profitable, and indicates that the pollen-analysis method has proved its flexibility by application to yet another aspect of post-glacial history. We may now look for confirmatory results in this special field from many other parts of Europe.

ANCIENT ASTROLOGY

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IN A.D. 1605 Sir Francis Bacon appended to the "Advancement of Learning" some prescriptions for posterity. These contain an injunction to construct "A Just Astrology". Bacon had previously assessed the then condition of this science in his main text. Like alchemy, astrology had a noble aim; like alchemy again, it had been more imaginative than rational; and, once more like alchemy, it needed the corrective and the purge. Astrology, as Bacon conceives it, is central and fundamental, for he defines it as "the real effects of the celestial bodies upon the terrestrial". This includes the action of the sun on the earth: without which there would be no astrology, because there would be no astrologers.

Posterity has obeyed Bacon in one way by sharpening and deepening its sense of absolute dependence on the sun. The cosmic course has made continuing human life possible by isolating the humble solar system in the vastness of space, and by placing the modest earth, with all its appropriate conditions, in nice adjustment to the solar rays. If the sun cooled down, mankind would freeze out; if it exploded into a fierce burst of radiation, the earth would become a great crematorium. If an invading body tore the earth too far away from the sun, or the sun from the earth, men would freeze; if it drove the earth and sun too near, or collided with the sun to make too fierce a furnace, men would burn. Invaders have far to come to reach an earth 4½ light-years away from the nearest star and very remote from the galactic depths. Though the importance of the sun is too obvious to be missed, the ancient mind probably grasped man's absolute dependence on it less completely than modern astronomy.

Plato's "Timæos" is very preoccupied with the sun as a measure of time, a revealer of number and a teacher of arithmetic. The moon, the planets and their motions share in the lessons. The Platonic Socrates, however, gives the sun its due in the "Republic" as the author of visibility, generation, nourishment and growth, though the sun itself is not generated. Modern astronomy, or, in Bacon's sense, astrology, does not confine celestial actions to the sun. The moon pulls more than the sun at the tides to produce their effects—on navigation, for example, or on some marine organisms. The cosmic rays still have their enigmas. If they do come partly from the stars and do act on genes, modern astrology will recognize some stellar influence. According to Aristotle's "De Cælo", the moving celestial bodies emit heat and light by rubbing against the air. The "Meteorologica" supplements this. Neither the moon nor any star gives out much heat: the moon is near, but too slow, and the star is rapid but too far off. The sun is both swift enough and near enough to warm the earth well. Though the two passages claim little for non-solar influences, they do indicate how readily celestial bodies could be presumed to affect the earth. The ancient mind did, in fact, as ancient astrology shows, very liberally supplement the celestial action of the sun.

Greek science, including astronomy, began on May 28, 585 B.C.: Thales predicted an eclipse of the sun for that day, and Nature obligingly darkened a battle between the Lydians and the Medes. This statement is too dramatic to be literally true, but Thales and the eclipse conveniently date the still accepted origin of Greek science (and philosophy) in the sixth century B.C. Thales was lucky, as Heath notes, for the Babylonian period on which he depended is less reliable for solar than for lunar eclipses. In 2159 B.C. the Chinese astronomers Hi and Ho were unlucky. Thales predicted an eclipse and gained prestige; Hi and Ho did not predict an eclipse and were executed.

From Thales the current of science runs to one great decisive century of thought—the fourth century B.C., the century dominated by Plato and Aristotle. In drastic summary, and so far as possible from the scientific point of view, a mathematical tradition runs from the anti-experimental Plato and a second trend of thought runs from Aristotle. Mathematics had its hand in astronomy and astrology. Science reaches an acme in the third century. In mathematics it includes Euclid and Archimedes; in astronomy it includes Eratosthenes, who measured the earth's diameter very accurately, and Aristarchos, who anticipated the Copernican theory. Herophilos founded scientific anatomy and Erasistratos founded scientific physiology. Then science begins to run into relative, though recognizable, termini. In the first century B.C. Lucretius stores the fundamentals of atomism in his famous poem, "De Rerum Natura",

for still far future centuries. Fortune has been capricious towards atomic theories. When the atoms tried to enter physics they were soon defeated ; their more determined attempt to enter medicine was finally foiled by Galen at the end of the great Greco-Roman period in A.D. 200. Many centuries after, the atoms became an extraordinarily fertile concept—one of the most fertile, perhaps the most fertile, of all physical theories.

Science is considerably consolidated from the first century B.C. to the first century A.D. in such writings as those of Cicero, Vitruvius and Plutarch. In the first and second centuries A.D. science drops into four relatively permanent and authoritative consolidations. In A.D. 77 Pliny pours a miscellany of facts, presumed facts and ideas into his "Natural History"—that "immense register", as Gibbon says, in which were "deposited the discoveries, the arts and the errors of mankind". It had its own authority and its own influence over future centuries, though it does state that elephants worship the stars.

Clarke, in his translation of Seneca's "Quæstiones Naturales", under the title "Physical Science in the Time of Nero", calls it the last deliverance of the classical world on physical speculation. Seneca authoritatively consolidates physics for coming centuries.

Singer, in "A Short History of Science", heads his chapter on the divorce of science and philosophy, from 300 B.C. to A.D. 200, "The Failure of Nerve". This expresses the decline of science rather oddly, for Ptolemy and Galen, in the second century A.D., are experimental and have at least a notion of the nature of scientific hypothesis. If the "Optics" as now known is as Ptolemy wrote it—and Thorndike thinks it is so substantially—it represents the most remarkable experimental research in antiquity. The oddness seems less when a candle is seen to flicker up before it dies. Science has before it the long path through the Middle Ages to the decisive seventeenth century. Ptolemy's consolidation of astronomy remains authoritative until Copernicus and Kepler in the sixteenth and seventeenth centuries. Galen's great biological, anatomical and medical synthesis, which includes his own inductive and experimental inquiries, remains authoritative until the sixteenth-century Vesalius. Seneca, the neo-Stoic, Ptolemy, the mathematician and astronomer, Galen, the physician—each consolidates the results of science in his own way. They have one belief in common—the control of human destiny by the planets and the stars.

In 1609 Kepler introduced the elliptical planetary orbit. This decisive step effectively made the transition from the geocentric Ptolemaic system to the heliocentric Copernican astronomy. Astrology had persisted during fourteen centuries after Galen, for Kepler still checked his own horoscope on his own life.

The horoscope displays the dispositions of the celestial bodies, or relevant celestial bodies, at a particular moment. When Johnson accused Dryden of "great confidence in the prognostications of judicial astrology", he meant that Dryden believed in the casting of nativities and even calculated them himself. Such *judicial* astrology casts the horoscope of birth or conception to determine the destiny of the born. Webster's "New International Dictionary" (1914) distinguishes *judicial* astrology, which predicts the destinies of individuals or nations, from *natural* astrology, which predicts natural events. Bacon included horoscope astrology in his purge. Seneca and Galen include the horoscope in their doctrine, though Galen's astrology is largely medical. Ptolemy describes the philosophy of horoscope astrology.

Nothing is too strange or incredible for some philosopher to believe—so judged the young Descartes when he was at college. Men have believed very many strange things, and perhaps they still do. A universe created as a compact mass and expanding from its terrific initial concentration may be among them. A modern cosmologist fortifies the doctrine by mathematics and dates the primal pack so far as 2×10^9 years ago. Horoscope astrology, however, is too significant a phase of thought to be eyed merely as a curious error.

Human thought has been fated to tread a predestined path, as an acorn steps its way to the oak. This is a good working principle if taken widely, if used in Sir Thomas Browne's "soft and flexible sense" and if not made a fetish by reason. The mind seems to have been committed to a magical phase, for example, though not to every magical detail. In any event, the route to such insight as has been attained has been through many illusions and errors. This is true of astronomy and astrology. The historian should consult the acorn and be wise, for the phases of thought should be contemplated as acorns and not merely chided for not being oaks. The future historian will probably see many acorns in the twentieth century—some promising, some sterile. Discarded hypotheses strew the devious path of science, and many astrological notions lie among them. These notions have at least one value still, for they give glimpses of the mind at work. Analysis conveniently derives them doubly from the concepts of their time and from impressions made by natural phenomena, though the two are ultimately and intimately connected.

Most men accept happiness as the chief good, though they disagree about its nature. This statement from the opening pages of Aristotle's "Ethics" has a modern ring. An otherwise well-educated man who knows nothing of Greek thought might conceivably mistake the "Ethics" or "Rhetoric" or "Poetics" of Aristotle for a modern work. This peculiarly educated man is a legitimate expository expedient to point a contrast. "A man's language ought to be easy for another to read, pronounce and point" : this sentence from the "Rhetoric" is modern enough. So is the notion adopted from Agathon in the "Poetics" : it is probable that many improbable things will happen. The supposititious reader would never mistake Aristotle's "De Cælo" or "Meteorologica" for a modern work. Intelligent stars, the roles of the four elements, easily credited spontaneous generations, for example, and the whole range of physical ideas date the two works relentlessly. Physics, in one very real sense, is the most fundamental science. It is very fundamental if men emerged from the cosmic course among the ephemeridæ of the universe. Greek philosophies almost invariably had their physics, and the earlier philosophies, at least, if they were assessed for the first time to-day, would probably be called philosophies of physics, as Eddington calls his work "The Philosophy of Physical Science". The physical world is more alien to us, in a recognizable sense, than the more domestic circle of human experience. Aristotle can deal with courage in the "Ethics", for example, or with the qualities of metaphors in the "Poetics" and the "Rhetoric", with more immediate success than he can secure in physics. A defective physics is one important item in the conceptual system that

promoted early astrologies. Greek philosophies regularly had their astronomies and astrologies.

Prospero's isle seemed to Caliban to be full of noises; the universe seemed to Seneca and Ptolemy to be pervaded by forces. The four traditional powers—dry, moist and, eminently, hot and cold—dynamically inter-connect the earth and the celestial bodies in the Ptolemaic universe. The heavens also send a force on to the earth. In Seneca's cosmology lightning has its subtle divine power, underground forces convert air into water, and a mighty force pervades Nature. Seneca's *force* is constantly modelled on the air, and the air itself, in various forms, is for him virtually a ubiquitous agent. It is the greatest of all powers for it kindles fire. The air drives trees up, holds our bodies together and stirs our souls, themselves a kind of air; a robust air keeps the earth compact and a fresh vital air from the earth supports life. The breath of the earth sustains the sun, the stars and the whole heavenly concourse. The inverted astrology of this statement contains a vivid sense of pervading cosmic forces. A crude physics assists this sense, and the cosmic spread of air provides an astrological agent.

Britain is great through the muscles of her sons, beef feeds the muscles, clover nourishes the cattle and bees fertilize the clover. Field-mice would destroy the bees, but cats kill the mice and old maids make Britain because they keep the cats. An item in the Hippocratic writings, whenever it was inserted, expresses the interconnexion of things less facetiously: if any one thing perished, all things would vanish. Every event, says Seneca, is a sign of an event to come. The sense of interconnected events is vivid in Stoicism.

Einstein's "cosmic religious feeling", stirred by the "sense of universal causation" and "the harmony of natural law", has its ancient analogue in the sense of the divine. In the "Apology" Socrates affirms a universal belief in the godhead of the sun or moon. Anaxagoras had been indicted because he called the sun a red-hot stone and the moon an earthy mass. In Plato's "Laws" the Athenian Stranger claims divinity for the sun, moon and stars against the earth and stones of mischievous philosophers. In the "Timæos" the stars and the planets are created gods; for Aristotle the stars, made of purest æther, are intelligent and divine. The divinity of the celestial bodies, as gods or godlike, persisted from Babylonian and Egyptian lore through the Greco-Roman tradition far into the Christian era. As Thorndike notes, Seneca studying the natural forces suggests the worshipper in the temple.

The Stoic Fate, however finally assessed, embodies two compelling concepts. It contains the belief in determinate causal connexions and natural law that emerged in Greek thought as the working faith of science. It contains also the sense of purpose, or aiming at ends, from which the Greek, or Greco-Roman, estimate of *cause* seldom got far away. Atomism had affronted this sense of the purposive too much to be welcomed for its sense of strict causality when Galen gave it the *coup de grâce* in medicine.

The ancient universe is physically misconstrued, pervaded by forces, interconnected throughout by determinately connected causes, a realm of natural law, a domain of sympathies or antipathies, suffused with purpose and impressively divine. "Astrology fell upon the Hellenistic mind as a new disease falls upon a remote island people": so writes Sir Gilbert Murray. Men realized truly that astronomy must finally achieve an astrology of some sort, though they tried to achieve it too quickly by inadequate means—this is a fair précis of a paragraph from Coleridge. The stars probably do mean something, John Selden thought in the seventeenth century, but astrologers cannot get at them to determine what. The stars *do* mean something and something can be known about the *what*—so thought Seneca, Ptolemy, Galen and many ancients.

Thucydides records how a lunar eclipse kept an Athenian host in port until the twenty-seven days prescribed by the soothsayers had passed. Samuel Pepys looked more imperturbably on the unfortunate comet that had lost its tail than many other eyes had looked on other comets. Eclipses, comets and many other astronomical or meteorological items took a hand in promoting astrologies. One item, in particular, had as many hands in the matter as Briareus. Pepys was recompensed for his toilsome studies of the moon's motions when it lighted him home on a dark night. Tiberius hoped to save his shorn poll from baldness by having his hair cut as the moon waxed. The belief in lunar control, the response of things or events to the lunar wax by increase and to the lunar wane by decrease, began early, extended to innumerable items and persisted pertinaciously.

Aristotle refers to the presumed connexion between moon and menstruation which runs through the tradition. In Galen the lunar phases still rule conception, birth and the "beginnings of actions": a belief rich in astrological possibilities. The innocent indifferent moon, which presumably knows nothing of such speculations, has been suspected of setting the whole astrological system going—horoscopes and all.

Neither Pythias, in the later fourth century B.C., when he correlated the lunar phases with the tides, nor Posidionius, about the first century B.C., when he recognized the combined tidal action of the moon and sun, drove the moon out of horoscope astrology. The moon hauls the tides; according to Galen it changes the air. If polluted air spreads disease, and the Hippocratic "Breaths" refers both life and sickness to the air, it may be infected from the skies. Pestilence can come from the sky if atoms from the great beyond can derange the air, as Lucretius sings, or atoms from the celestial bodies can spread epidemics, as Democritus affirms. Though the atomists are condemned by Galen for refusing astrology, they can accept widespread celestial actions by invading atoms.

In Aristotle and Galen the air connects the earth with the heavenly bodies. Under "Astronomy" in James's "A Medicinal Dictionary" (A.D. 1743), the sun, moon, planets and stars are said to act on terrestrial bodies through the æther and the atmosphere: even the distant stars affect human bodies by disturbing the air. Astrology, horoscopic or non-horoscopic, constantly trusts in the moon's power and relies on the astrological agency of air.

The astrological tradition is perceptible in the "Timæos", in the terrors sent and intimations given to expert calculators by the combined motions of the planets. The horoscope invades Stoicism, Rome and Greco-Roman thought during the second and first centuries B.C. Two dissentients mark the invasion: Panætios the Stoic in the second century and Cicero in the first. The signs of the zodiac connect modern astronomy with astrology and with

its origin, for they admittedly come from Babylonia. The tradition insistently refers the origin of astrology to the Chaldæans.

Berossos the Babylonian wrote a history of his country in the third century B.C. As the tradition appears in Vitruvius, for example, the Chaldæans cast nativities, Berossos presses their astrology on his school at Cos, Antipater and Archinapolos alter the horoscope from birth to conception, and astrology grips Greco-Roman thought. The encyclopædic history of Diodoros, about 30 B.C., describes the theory and method of the Chaldæans: the events of the heavens intimate the thoughts of the gods, so the stars were observed for many ages. So astrological theory promoted astronomy. The Babylonians are said to have checked horoscopes on the recorded lives of Babylonian boys. Even if they did this for less than the 470 years of one more moderate estimate, their inductive effort, if not their deductive doctrine, must be reckoned as scientific righteousness.

Did all the Romans who fell at Cannæ have the same horoscope? Cicero's question sounds pertinent. When the birth of Firminus was nigh, a slave-woman of his father's house was also near her delivery. Messengers were posted in either house to run to the other with news of each birth. The two messengers met so exactly in the middle of the way that the two births must have happened at precisely the same instant. Yet, St. Augustine further records, Firminus was born to increasing riches and honours, but the slave-born child was born to continued slavery. Cicero and St. Augustine argue inversely against the horoscope: Cicero from one fate and different horoscopes; St. Augustine from one horoscope and different fates. Either argument might be valid if, and only if, the disposition of the heavenly bodies at birth is the singly decisive decider of destiny. Ptolemy denies that it is singly decisive.

An anticipatory reply to St. Augustine can be shortly constructed from Ptolemy's "Tetrabiblos". Famines, pestilences, wars and the like, which affect large areas, whole peoples and cities, are more surely predicted than single human actions. The effect of the stars on the human individual is conditioned by his nationality, his country and his domicile. It is also conditioned by his period, for time varies the celestial actions. Firminus and the slave were born at the same time, in the same city and among the same people, but under different social conditions. They were also differently educated. Ptolemy disclaims an astrological narrowness if previous astrologers had ignored place, weather and heredity, as Cicero, in the "De Divinatione", says they did.

Ptolemy insists on the complexities of the celestial dispositions, on the manifold causes acting on the individual, and on the present imperfections of astrology. Predictions often fail because the science is immature, but frequent shipwrecks do not destroy the art of navigation. Ptolemy's frank admission of predictive failures contrasts with the bold statement by Diodoros that when the Chaldæans prophesied about kings they were always right.

Ptolemy repudiates impostors. He claims that the science has present value in spite of imperfections or failures, and that time will increase the value. Astrology is not useless because the stars decree inevitably: if they do cause a disease, a drug may cure it. Ptolemy manifests a recognizably scientific temper in handling a now discredited hypothesis.

Scientific inquiry is not incompatible with cosmic purposes, for Galen inquired how purposive Nature purposes. It is not incompatible with Providential ordering, for Galen inquired into the natural law through which God works, though the existence of God did not seem to him to be proved. If the stars do operate divine purposes, astrology can still have its operative scheme, as Galen had his attractive forces. A force radiated from the stars is central in early astrological doctrine—Cicero notes how the Chaldæans lodge it in the zodiac, Ptolemy speaks of the force diffused from the heavens on terrestrial things, and according to Galen "we receive the force of all the stars above". This force is variously affected by the sun, moon and planets according to their positions, conjunctions and relations to the signs of the zodiac. Other powers may co-operate, such as hot or cold, and an eye is often kept on the astrological agency of the air.

The moon is constantly prominent in the astrological versions. It has no more power than the other planets, Galen explains, but it is nearer. The Chaldæans, Cicero tells us, were careful to note the condition of the moon and its conjunctions with the stars at the moment of birth. The moon is usually peculiarly important in astrological theory, Thorndike notes, and more distant planets often act on the earth through it. It is quite reasonably, even if unjustifiably, suspected of inflicting genethlialogy, the science of nativities, upon many minds through many centuries.

The Chaldæan type of astrology is one hypothesis which marks the route of science. It seems to be an intelligible consequence of one phase in human thinking, and perhaps more so because man very earnestly wants to know what will happen.

PRE-NEANDERTHAL MAN IN THE CRIMEA

By Sir ARTHUR KEITH, F.R.S.

In 1925 there appeared an annotation in *L'Anthropologie*[1] directing attention to the discoveries of ancient man and of his cultures then being made in the Crimea by G. A. Bonč-Osmolovskij, conservator of the Russian Museum in Leningrad. The chief site of these discoveries was the grotto or rock-shelter of Kiik-Koba, situated in the foothills of the Yaila Mountains, which run from Sebastopol towards the Kerch Straits. In the deepest and oldest stratum of the grotto were found fossil remains of part of a human skeleton; these were reported to be Neanderthal in character; they were examined by the late Dr. Marcelin Boule, who confirmed this diagnosis. The Crimea was then the most easterly point from which Neanderthal man had been reported. Students of early man were deeply interested in the discoveries reported by their Russian colleague and have eagerly awaited his full report—so far in vain. Recently my interest in Kiik-Koba was heightened by an article published in *Man* by Prof. Gordon Childe[2], in which the strata of the grotto are identified as similar in age and in sequence to those which yielded the fossil men of Mount Carmel—the subject of a report published by Dr. Theodore McCown and myself in 1939[3]. In February of the present year (1944) a pleasant surprise awaited me; on opening a parcel bearing the Moscow postmark, I found within a volume entitled

—in the French translation kindly supplied by the author—"L'Homme fossile de la Grotte de Kiik-Koba (Crimée)". I found it to be Part 2 of the "Paleolit Kryma"*, published in Moscow in 1941. Part 1, which gives an account of the strata of the grotto and of their contents, was published in 1940. Inside the cover of the book which came to me so unexpectedly, the author has written an inscription in English; it is signed G. A. Bonč-Osmolovskij and dated December 10, 1942. Considering the obstacles which lay between the author and myself, the wonder is, not that the book took more than a year to reach me, but that it ever arrived.

As I came to know the contents of this book, which was made possible for me by the author's full résumé in French and by his supplying the numerous illustrations with legends in that language, I saw why we had had to wait so long for this report. Part 2 consists of 171 closely printed pages of Russian text, all of it devoted to one part of the Kiik-Kobian man—the hand. Men of the early Pleistocene are represented by specimens from Java, China, Heidelberg and Piltdown; the later Pleistocene has given us a score or more of fossil Neanthalians, all from Mousterian sites, but of the men of the middle Pleistocene we know very little. It was the realization of this blank in our knowledge that made the author resolve to squeeze every item of information from the fossil bones of the Kiik-Kobian hand to an extent that has never before been attempted. He had at his disposal only two bones of the carpus (trapezium, trapezoid); two of the ten metacarpi (those of the thumb and ring finger); and fourteen phalanges of the fingers. Some of the bones belong to the right hand and some to the left; by using mirror-images of the left bones he was able to incorporate them into a reconstruction of the Kiik-Kobian right hand. In the course of doing this he observed that those of the right were slightly the larger, pointing to right-handedness. To give his inferences a wide foundation, the author has extended his inquiries to the hands of modern man and of apes, and to the embryology of the hand of man and of apes; in short, he has constructed a new branch of inferential anatomy. He set out to give a description of a mid-Pleistocene European and ended by giving not only such a description but also what amounts to a treatise on the evolution of the human hand.

Kiik-Kobian man belongs to an age which precedes that which marks the appearance of Neanderthal man in Western Europe; he represents the folk of the upper or later Acheulean period of stone-culture. The only other site which had yielded fossil remains of Acheulean man, so far as M. Bonč-Osmolovskij could learn, was the Tabūn cave of Mount Carmel excavated (1929–34) by an expedition sent out by the British School of Archæology in Jerusalem and the American School of Prehistoric Research under the direction of Prof. Dorothy Garrod[4]. At Tabūn the superimposed cave deposits reached the enormous depth of 80 ft.; as at Kiik-Koba, the bottom stratum was of the remote palæolithic age known as Tayacian; in this ancient stratum Kiik-Kobian man had been buried—the oldest human grave known to us as yet. Over the bottom stratum, at Tabūn as at Kiik-Koba, come deposits of the later Acheulean, having a thickness of 16 ft. at Tabūn. Then, at Tabūn but not at Kiik-Koba, there follow strata—40 ft. of them—laid down during the period of Mousterian culture. The company of fossil Carmelites described by Dr. McCown and myself came from the deeper Mousterian layers. The Acheulean deposits yielded us only two fossil fragments—the greater part of the shaft of a femur and a worn lower molar tooth. We estimated the original length of the Tabūn femur, and from that gave the Tabūn Acheulean man a stature of 1·656 m. (5ft. 5in.); the Kiik-Kobian man is estimated (from the length of his tibia) to have been about 1·59 m. (5ft. 2·6in.). On comparing the femur and molar from the Acheulean deposits with the corresponding parts of the Mousterian Carmelites, we found a degree of correspondence that led us to regard the Acheuleans of Tabūn as probably ancestral to the Carmelites. The cultural evidence, however, is against our supposition, for Prof. Garrod noted a definite change in the type of stone implement on passing from the Acheulean to the Mousterian strata.

There was no femur, no molar tooth, found at Kiik-Koba with which we might compare our Tabūn specimens. When, however, we compare the Crimean hand-bones with those of the Mousterian Carmelites, we find them sharing in certain features which are also present in the hand-bones of Neanderthal man, but not in those of modern man. But in their massiveness and in their ruggedness the hand-bones of Kiik-Kobian man show a primitive characterization. He may well have been, as Bonč-Osmolovskij claims, ancestral to the Neanderthalians of Europe. Heidelberg man, who is known only by his lower jaw, has also a claim to be on the Neanderthalian ancestral line; a worn lower incisor, the only tooth found at Kiik-Koba, would be in place in a Heidelbergian mandible.

His painstaking methods have permitted M. Bonč-Osmolovskij to unfold a strange act of vandalism on the part of the Acheulean cave-men of Kiik-Koba. Not only had a man been buried in the bottom stratum, but also a child of about one year in age had been laid to rest near him, with its head directed towards his. Afterwards, for some unknown reason, the Acheuleans excavated and threw out that part of the floor of their cave which contained the graves, leaving *in situ* only the feet, right leg bones and parts of both hands of the man and those parts of the child which lie below the waist. Of the missing parts of the two individuals, only a worn lower incisor was recovered.

The author has my warm approval when he names this Crimean fossil type simply Kiik-Kobian man—*Homo kiik-kobiensis*. Future discoveries will reveal his exact place in the scheme of human evolution. But I doubt if my British colleagues will agree with him in the place he assigns to his fossil type in the scale of time. He places it, not in the last great interglacial period—the Riss-Würm—but towards the end of the preceding interglacial, the Mindel-Riss. Miss D. M. A. Bate[5] has reported on the fossil fauna from Tabūn; she found that the chief change took place, not at the end of the Acheulean period, but towards the end of the Mousterian. Consequently the Acheulean as well as the Mousterian cultures at Tabūn are regarded as lying in the Riss-Würm interglacial.

Bonč-Osmolovskij gives the Kiik-Kobian the short, thick and squat hand of a labouring man; he was a labourer who used stone tools. He quotes Engels to

* Paleolit Kryma. By G. A. Bonč-Osmolovskij. Vypusk 2: Kist' iskopaemogo čeloveka iz grota Kiik-Koba. (With a résumé in French.) Pp. 172+8 plates. (Moscow and Leningrad: Akademie Nauk SSSR, 1941.) 16.50 roubles.

the effect that "la main n'est pas seulement un organ de travail; elle en est aussi un produit". Our Carmelites also laboured with stone tools, but their hands had the shape and proportions still to be seen in native races. The author regards the squat, plate-like hand and foot which appear in the embryonic stage of man and ape as the original primate type; Kiik-Kobian man, he believes, has retained this type. He seeks to explain the retention of the primitive form of hand in man by supposing that man never was a tree climber, as his anthropoid cousins became, but that he was evolved in treeless surroundings, such as those which now exist in South Africa. He follows with a lively interest the history of the fossil South African anthropoids as it is being unfolded by Dr. Robert Broom and Prof. Raymond Dart, and expects to find support for his theory from that source. I, on the other hand, regard the embryonic hand of man and ape as representative of a structure which never had existence outside the womb; the embryonic hand depicts a stage in development, not in evolution. I seek to account for man's form of hand by supposing that even in the arboreal stage of his evolution, when he was a climbing animal, his lower extremities and feet were his chief means of support; his hands were never modified to form hooks, as in his hand-clinging anthropoid cousins[6].

My Russian colleague and I seem fated to construe prehistoric facts in a contrary manner. To him the fossil men of Java, of Peking, of Kiik-Koba, of Neanderthal, represent an ascending series which culminates, without a break, in *Homo sapiens*. For me, these pleistocene types represent separate evolutionary products, each being at a different stage of evolution. Bagehot showed a remarkable prescience when he declared (1869) that ancient races of mankind were "parish races". A transitional Neanderthal-Modern type has been discovered in Palestine but never in Europe. In Java, the early Pithecanthropoid is now linked to a later Australoid form by a series of fossil intermediates. The English contemporary of the Kiik-Kobians—the man whose skull was discovered deep in the Acheulean gravels at Swanscombe in the Thames valley by Mr. Alvan Marston in 1935[7], was not at all Kiik-Kobian in type. So far as his characters can be made out, they link him, not to the Neanderthalians, but to the earliest known fossil type in Britain—Piltdown man[8]. Our evidence as it now stands is very imperfect, but such as it is, it entitles us to assume that the British peninsula of Europe had, in earliest pleistocene times, its own type of humanity.

Although my interpretations clash with those of my Russian colleague at several points, that does not blind me to the fact that he has made a contribution to our knowledge of the highest importance; he has enriched our modes of anthropological inquiry, as well as our armoury of fact. Students of human evolution await the monographs which will complete his Kiik-Kobian studies with a lively interest.

[1] Keith, Sir A., "New Discoveries relating to the Antiquity of Man" (1931), 363.

[2] Childe, V. Gordon, *Man*, 98 (1942).

[3] McCown and Keith, "The Stone Age of Mount Carmel. The Fossil Human Remains from the Levalloiso-Mousterian", **2** (1939).

[4] Garrod, D. A. E., and Bate, D. M. A., "The Stone Age of Mount Carmel", 1 (1937).

[5] See under 4, p. 139.

[6] Keith, Sir A., *Amer. J. Phys. Anthrop.*, **26**, 251 (1940).

[7] Marston, Alvan T., *J. Roy. Anthrop. Inst.*, **67**, 339 (1937).

[8] Keith, Sir A., *J. Anat.*, **73**, 155 and 234 (1939).

OBITUARIES

Prof. L. R. Wilberforce

Lionel Robert Wilberforce, eldest son of Edward Wilberforce, Master of the Supreme Court, and great-grandson of William Wilberforce, the emancipator, was born at Munich on April 18, 1861. After receiving his early education at the London International College, Isleworth, he became a foundation scholar of Trinity College, Cambridge. He graduated as thirteenth Wrangler and obtained a first class in the Natural Science Tripos.

In 1887 Wilberforce was appointed assistant demonstrator to Sir J. J. Thomson at Cambridge, becoming demonstrator in 1890 and University lecturer in physics in 1900. In the same year he succeeded Sir Oliver Lodge as professor of physics in the University of Liverpool, where he was at once faced with the planning of a new laboratory. This work was so well done that, except for limitations of space, it has satisfied most of the needs of present-day workers. It was in this laboratory that Barkla discovered the characteristic X-ray radiations of the elements. Some years previous to this, Wilberforce had suggested the now well-known method of investigating the polarization of X-rays, which in the able hands of Barkla provided the first real evidence of the undulatory nature of X-rays.

Judged by modern standards, the number of scientific papers published by Wilberforce is not large. His interests covered almost the whole range of classical physics. In his Cambridge days he wrote on surface tension, viscosity, the vibration of loaded spiral springs and miscellaneous electrical topics. A fascinating product of his work on springs is the comparatively little-known Wilberforce spring which admirably illustrates the periodic transfer of energy from translation to rotation. Wilberforce was a strong advocate of the kinematic design of instruments. His kinematic clamps and boss head, which he described in a lecture to the Physical Society in 1932, have given much satisfaction in many laboratories. In his later years, Wilberforce became interested in the subject of electrical units, and was in frequent correspondence with the late Sir Richard Glazebrook. Arising from this were two penetrating papers on magnetism in the *Proceedings of the Physical Society* of 1933 and 1934.

Wilberforce was an excellent teacher. He had a thorough understanding of all types of students. For the beginner he wrote, with Fitzpatrick, "A Laboratory Note Book of Elementary Practical Physics". That he had a clear perception of the difficulties involved in the teaching of physics is brought out in the interesting chapter he contributed to "A History of the Cavendish Laboratory". He took great pains to make physics attractive to his students. His lectures were almost lavishly illustrated with experiments, the demonstration of which gave him much delight. In describing physical phenomena—always in his own way—he seemed to prefer words to symbols. It is, however, as a popular lecturer that he will be most widely remembered. He devoted an extraordinary amount of time to the perfection of his lecture demonstrations. He was quite early in the field with an ingeniously constructed wave model and ripple tank which he exhibited on many occasions.

Wilberforce excelled as an administrator. His courtesy, ready wit, genial personality and clarity

of outlook were important factors in making him a most successful chairman of the many university committees on which he served. His work as acting vice-chancellor of the University of Liverpool for one session was much appreciated.

Wilberforce vacated the Lyon Jones chair of physics in 1935 in full vigour. He continued to serve on the committee of the Liverpool Maternity Hospital, of which he had been vice-president for more than twenty years, and on the committee of the Liverpool Radium Institute, besides taking an active interest in church work.

No account of Wilberforce would be complete without reference to his mountaineering activities and his great skill as a skater, which he maintained almost to the time of his death in his eighty-third year. R. W. Roberts.

Sir Thomas Ranken Lyle, F.R.S.

Former students of the University of Melbourne in all parts of the world will be sorry at the death in Melbourne of Sir Thomas Ranken Lyle, at the age of eighty-three. Lyle came from Dublin, after an academic career of distinction (enhanced by three years of playing Rugby for Ireland), to the Melbourne chair of natural philosophy in 1889, when the University was in its thirty-sixth year and he in his thirtieth; he held the professorship for more than a quarter-century, and thereafter continued to give valuable services to the State of Victoria until a few years ago.

In the school of physics Lyle had at first much to build up—though on a sound foundation—and he very soon became one of the vigorous group of young professors who in the ensuing years did great work in advancing the University both internally and by reputation. Lyle's direct contributions to physics, especially in the principles of current generation in dynamos, were recognized in 1912 by the fellowship of the Royal Society. His knighthood came in 1922.

In the more elementary parts of his teaching, to students of engineering and medicine as well as science, Lyle imparted even to backward members of a class solid realities and conceptions which endured. For the better students, and in senior work, he laid very fine foundations indeed. No one who was in Lyle's classes could forget his firm good-humour, his benign tolerance of the mathematical weakling. He himself was a strong mathematician, though his first-year men—confusing arithmetic with mathematics—were apt to watch hopefully for the contest for the right result between any of his admirable lecture-bench experiments and his impatient manipulation of a Fuller's slide-rule in working them out. As befitted a good experimenter, any error was always debited to the slide rule. But no student took liberties with Lyle; they all felt too much respect and affection towards him for that. He did not seek this: he received it. His strong and honourable common sense, his shrewdness that stooped to nothing petty, the reserves of his judgment and its cogency when he did give it utterance, helped to make him a force in the whole University and, coupled with a geniality brought from his native land, made him a friend for life of its other best men.

Retiring fairly early from his chair, Lyle was called upon to give advice to the State on educational questions and, especially, on large technical developments: first as chairman of the Electricity Commission of Victoria and then for nearly twenty years more a member, he did very important public work which, with his impress on the University, has had effects which will endure.

Lyle married Clare Millear in 1892; and their family have made high places of their own in Australian affairs. J. I. O. Masson.

Mr. S. E. Winbolt

Archæology has lost a keen worker by the death, at the age of seventy-six, of Samuel Edward Winbolt. Educated at Christ's Hospital and at Corpus Christi College, Oxford, where he took high classical honours, he returned to Christ's Hospital as a master. There he published some educational editions of the classics and other works on history and English literature. His classical training turned his attention naturally to Roman and kindred archæology, to which he devoted himself upon his retirement.

Winbolt's most important work was the excavation of the large Roman villa at Folkestone, published in book form, "Roman Folkestone", in 1925; the smaller villa at Southwick, Sussex, owned by the Sussex Archæological Trust; the posting stations on Stane Street and other detailed investigations upon this Roman road, published recently in "With a Spade on Stane Street", which will be the standard authority on this road; a series of camps of the Early Iron Age in the Weald ranging from Tonbridge to Hascombe; and the rediscovery of the sites of the important local medieval glass industry at Chiddingfold, near Horsham, published in book form, "Wealden Glass" (Combridge, Hove), in 1933.

Winbolt contributed the Romano-British portion, an important collection of material of the volume on Sussex, in the Victoria County History. He prepared some attractive guides for Bell's county series, including Sussex, Kent, Devon, Somerset and others. He had a gift for the popular exposition of archæology and one of his last works was a Pelican book on prehistoric Britain, "Britain B.C.". A most helpful correspondent, he had great charm of manner, and the important knack of encouraging beginners and young helpers in archæology. I. D. Margary.

Prof. L. S. Palmer

Prof. L. S. Palmer, chief in the Division of Agricultural Biochemistry of the Department of Agriculture at the University of Minnesota, died on March 8 at the age of fifty-six. Dr. Palmer had been at the University of Minnesota since 1919 and became head of the division at University Farm a year ago, succeeding the late Dr. Ross A. Gortner. More than thirty years of research and teaching at the Universities of Missouri and Minnesota had earned for him wide recognition as a chemist, especially in the field of dairy science and nutrition. He was the first recipient of the Borden Award for outstanding research in the chemistry of milk.

While Dr. Palmer's investigations carried him into many of the broad phases of nutrition and vitamin values, his principal interest was in such fields as the pigments of milk and butter, the cause of butter defects and storage troubles, the physical and colloid chemistry of milk and the churning process. He carried out extensive research in animal nutrition, with stress on the mineral needs of dairy cattle and the relation of feeding to dairy production and quality.

NEWS and VIEWS

Science and Research in Great Britain

THE debate which took place in the House of Commons on April 19 on Sir Granville Gibson's motion urging "the declaration of a bold and generous Government policy of financial assistance directed to the expansion of teaching and research facilities in our universities and technical colleges, to the extension of pure and applied research in all fields by the State, by industry through private firms and research associations and to the effective and rapid application of the results of research", in connexion with which the White Paper on Scientific Research and Development (Cmd. 6514) had been issued, covered much of the ground of recent reports of the Parliamentary and Scientific Committee and other bodies, as well as the recent lectures on science and industry arranged by the Manchester Chamber of Commerce. Sir Granville said that in regard to the research associations the Government grant has not increased in proportion with the increase in contributions from industry. An increase in expenditure on research of anything up to £15,000,000 would be a valuable investment for the country's future. Like Mr. Edmund Harvey and others who followed, Sir Granville pointed out that the staffs of the research and scientific departments of the colleges of Great Britain are far too small, and Mr. Salt, who followed him, urged that the number of research workers should be doubled. On particular fields of research, Mr. Salt instanced coal research as specially important ; Sir Ernest Shepperson stressed the need for agricultural research, particularly in relation to nutrition, and was supported by Mr. R. C. Morrison, Dr. Haden Guest and Major York, as well as by Mr. Snadden, who referred especially to veterinary research ; Sir John Graham Kerr referred to fisheries research, while Mr. Owen Evans and Mr. James Griffiths directed attention to the neglect of geological research and surveys. Sir George Schuster said that more attention should be given to our failure to make full use of the knowledge gained from the limited research carried out, and urged that, first, a more scientific frame of mind must be created in British industry ; secondly, closer contact should be established between those engaged in pure scientific research and those concerned with its practical applications ; and thirdly, means should be found to assist the development stage and the practical evolution of new industrial ideas.

The Lord President of the Council, Mr. Attlee, replying on the debate, said that the amendment was in full accord with the policy which the Government is following now and which it desires should be followed in the post-war period. The Government is fully alive to the fact that the winning of the peace will depend largely on a full and right use of scientific men and organizations. Assistance will be given in a bold policy, and the Government will take a lead, but it must be backed by a readiness to use the results of that research and by public opinion. The nation must become more aware of the importance of science. We shall be utilizing scientific methods throughout our activities of Government and of industry, and industry must be ready to take advantage of the new openings which the application of scientific research affords. The Government is also examining the need for the establishment of a fund to meet the cost of developing new inventions and of providing facilities for testing new ideas for industry, as well as how best to fit this in with the work of the co-operative research associations. The Government is also entirely in favour of generous support for the extension of teaching and research in the universities of Britain, but Mr. Attlee questioned the practicability of any statutory university advisory council. Mr. Attlee, welcoming references in the debate to the remuneration of scientific workers, said that the whole question of the relative remuneration of scientific workers in Government service is under investigation and steps have already been taken to raise the remuneration of the heads of research institutions. He thought a Ministry of Science would be a great mistake : what we need is to see that there are persons in all departments who are trained in the scientific method and appreciate what it means. Finally, he referred to the considerable improvement in the machinery of government through the creation of a Central Statistical Section and a Central Economic Section. He welcomed the debate as promoting the formation of an informed public opinion which would support a sustained effort.

Control of German Chemical Industry

IN the House of Lords on April 18, Lord Vansittart raised the question of the control of German chemical industry after the War. In particular, he asked for the appointment of a committee of scientific men to prepare a suitable scheme for the control or elimination of Germany's nitrate and hydrogenation plants. Such control might involve a close watch on German scientific education and research, and even the limitation of manufacture of certain high-precision instruments. There will be general agreement with his view that scientific men are best able to devise means to achieve such restriction and control. Lord Vansittart was supported by Lord Horder, who mentioned two synthetic drugs, used in the treating of sleeping sickness and malaria respectively, the supply of which had been deliberately restricted in countries outside Germany as a part of the Nazi preparation for total warfare. Lord Strabolgi and Lord Farringdon sounded a note of caution, pointing out that to cut down German nitrate production unduly would have a harmful effect on European agriculture and would in the end impede the work of re-establishing the health of the people.

The Government reply was given by Lord Cherwell, Paymaster-General. He said that various committees have been considering the questions involved, and the Government intends not only to call in more expert advice but also to give great attention to the recommendations made. He agreed that to prevent Germany from manufacturing nitrate and ammonia would create difficulty in supplying Central Europe with fertilizers, but German research will have to be supervised. The question of the control of German chemical industry is part of the much larger question of curbing the German war potential, and the Government is prepared to take every step possible to achieve this end.

It is indeed welcome news that the Government has this matter under consideration, and that scientific workers, whose special competence in this field is obvious, are to take a prominent part in formulating policy. It will be recalled that the matter was raised by Sir Robert Robinson so long ago as early in 1943, at the annual luncheon of the Parliamentary and Scientific Committee, and some of the problems involved have been discussed in these columns (see

NATURE, 151, 455 and 562; 1943). No time should be lost in bringing together those with the widest knowledge of the chemical, engineering and industrial problems involved, in order that a practicable scheme of control may be ready for operation as soon as hostilities cease.

Science and Industry at Manchester

IN presiding at the last of the series of meetings on "Science and Industry", arranged by the Manchester Chamber of Commerce, on April 20, the president, Mr. A. H. S. Hinchliffe, stated that to give continuity to the interest stimulated by the meetings and improve the liaison between scientific workers engaged on research and the industrial and commercial world, the Chamber has been discussing with the University of Manchester the formation of a joint standing council the members of which would be nominated by the University and the Chamber. The Cotton Industry Research Association is to be invited to take part in the work of the proposed council, which is intended to be an advisory and consultative body. While its precise functions cannot yet be defined, it is hoped that the results of research work would be constructively examined and discussed and the workers benefited by access to the experience of firms in the area. At the same time, business people would be assisted in their quest for new knowledge and in the solution of difficulties. It might even be possible to establish a bureau of information, and the range of subjects open for discussion in the council would cover economics and sociology as well as technical matters. The council's aim should be to stimulate an advance of thought and encourage enterprising action, primarily in the North-Western area but, it was hoped, also in a much wider sphere. Sir E. Raymond Streat urged, in supporting the proposal, that if, in the coming age of research, we could weave the life and work of the University of Manchester into the life and work of the great industrial area and commercial centre which surrounds the University, we might produce a great vitalizing force. The interest evoked by the meetings shows that people holding responsible positions in industry and commerce in Lancashire realize that only by a fertile marriage between science and industry can we establish and maintain the margin of superiority essential for post-war prosperity. He suggested three main objectives: to be first with new inventions and discoveries and promptest in their application; to be quickest and surest in diagnosis of economic and technical trends; and to be foremost in economizing costs so as to be more competitive without lowering wages. The age of research does not imply disaster for all small firms, though their managers will need much fuller scientific and technical attainments than was customary in the past.

Fundamental Scientific Research and the State

SIR EDWARD APPLETON'S final address in the Manchester series dealt with "Fundamental Scientific Research and its Practical Importance". Sir Edward said that he believes it is still necessary to insist that there is no barrier between so-called pure and applied research. There is great danger that the general public should regard the scientific man as one whose sole task is to produce a succession of discoveries of immediate use to industry, or of direct use to the individual member of the community. The main theme of his address was the wisdom of ensuring that there should continue to be in Great Britain many active research groups the scientific work of which would be that of free inquiry and the extension of man's knowledge of Nature, without concern as to whether the final results are of practical use to humanity or not. Emphasizing and illustrating the way in which most of the scientific developments of the present century had their origin in purely scientific work conducted with no thought of utility, Sir Edward pointed out that we also owe to workers in the field of pure science the scientific method of inquiry by observation, experiment and theory. It is, of course, also important that there should be practical men eager to test the properties of the new compounds and materials, and that applied scientists should keep themselves constantly in touch with the development of new knowledge, so that the gap between discovery and its application may be bridged as quickly as possible.

With regard to the conditions of success in fundamental research, chance often plays an important part. Fundamental research flourishes most abundantly in an atmosphere of freedom and, accordingly, Sir Edward believes we must look to our universities for the main body of our fundamental research. We must also recognize the importance of the man of exceptional originality and imagination, and see that he is supplied with the facilities he needs. Industrial research organizations and Government research departments should also contribute to the general body of fundamental knowledge, and he believes it to be the function of the Agricultural Research Council, the Department of Scientific and Industrial Research and the Medical Research Council to pursue fundamental research in fields which are ultimately likely to be of practical benefit to the community. Both Government and industry are awakening to the importance of scientific research and the need for its extension and application, but the large post-war developments in industrial research and technology must be sustained by an adequate volume of fundamental research.

United Nations Educational Reconstruction Plans

A TENTATIVE draft constitution for a United Nations Organization for Educational and Cultural Reconstruction was accepted by the Conference of Allied Ministers of Education at a meeting on April 19. If adopted by the Allied and Associated Governments, it will permit joint efforts in this field in line with parallel work already being developed by the Food Conference and the United Nations Relief and Rehabilitation Administration. The projected Organization would direct its activities at first to the emergency work of restoring the educational systems and the cultural institutions destroyed by the Axis Powers. Experience gained in carrying out these emergency tasks would create a basis for lasting international co-operation in educational and cultural fields. The proposed constitution was drafted at two open meetings convened by the Conference of Allied Ministers of Education and the American Education Delegation, led by Congressman Fulbright, which came to London early this month to work out plans for American collaboration with the Conference. The meetings were attended by representatives of all member and observer States currently interested in the Conference and were presided over by Mr. Fulbright. The device of holding open meetings enabled all representatives

present to participate fully, equally and without prejudice to their positions in the Conference.

The text of the tentative draft constitution for the proposed Organization consists of seven sections. It opens with a statement of the underlying reasons why international co-operation in educational reconstruction should be attempted. The functions of the projected Organization are then defined in terms which should permit it to work effectively in the fields of educational and cultural rehabilitation and reconstruction, and to develop ultimately into a permanent body with broader activities. Membership is to be open to all the United Nations and Associated Nations and to such other nations as shall be accepted by the assembly, upon application thereto, after the cessation of hostilities with the Axis Powers. Provision is made for an assembly with equal representation and votes for all member States, an executive board to be elected by the assembly and an international secretariat. The financial section states that administrative expenses shall be shared by the member nations on a basis to be agreed by the assembly. It also provides for the creation of an Emergency Rehabilitation Fund controlled by a committee, which will fix contributions and also make allocations from the Fund. The committee will consist of representatives of the three States making the largest contributions for administrative expenses and three members elected by the executive board. Member nations would be required to supply information about education and cultural matters. Provision is also made for defining the legal status of the Organization and its staff, providing for co-operation between the Organization and existing international organizations in the educational and cultural fields, and governing the relationship of the Organization to any agency for co-ordinating public international organizations.

Clinical Use of Penicillin

THE issue of the *British Medical Journal* dated April 15 includes eight papers which record the results of work done at one of the four main centres established in March 1943 by the Penicillin Clinical Trials Committee of the Medical Research Council. A leading article comments on these papers and on other work in the United States, where much larger supplies of penicillin are available, so that work on a larger scale is possible. In the first article, Prof. L. P. Garrod and Dr. Christie describe the work and policy of the centre at which all this work was done. Other articles deal with the systemic administration of penicillin by continuous intravenous drip, intramuscular injection, drip transfusion into the bone marrow of the sternum and continuous intramuscular drip transfusion; with the effects of penicillin on infections of the mandible and of bone, the latter indicating that treatment of chronic bone infections is not yet satisfactory; with its use as a local application to lesions of soft tissues (wounds, abscesses, cellulitis and infected skin eruptions); and its effects on breast abscess and certain skin diseases.

A final article by Prof. Garrod explains the extensive laboratory work which is necessary if the clinical work is to be properly controlled. Penicillin is supplied in the form of a powder or tablets and solutions have to be made from these. Because penicillin is a very labile substance, and because many bacteria are quite unaffected by it and may, therefore, live in these solutions or even decompose them so that they lose their activity, the greatest care is necessary in making up the solutions. Further, it is advisable to determine, before treatment, what micro-organism is being treated and the sensitivity of the particular strain concerned, because certain strains of some kinds of bacteria (especially Staphylococcus) vary in their resistance to penicillin. It is also necessary to obtain swabs from the patients to check by *in vitro* methods the effects of treatment. Because the therapeutic effect depends on keeping up a sufficient concentration of penicillin in the lesion, the concentration actually being maintained must be ascertained from samples taken from the patient. Estimations of the penicillin content of the blood are also done.

It will do no harm, perhaps, to repeat Prof. Garrod's reminder that it is of the first importance to realize that penicillin acts only on certain bacteria, most of which are Gram-positive, the chief exceptions being the gonococcus and meningococcus; and that certain bacteria are highly resistant to it. On the other hand, it has, he says, enormous antiseptic power, is almost completely indifferent to the medium in which it acts and almost completely non-toxic to the body as a whole. Clearly everything possible is being done in Great Britain and elsewhere to apply this remarkable antibacterial substance to the relief of suffering in man and animals. Those who impatiently demand quicker progress are evidently unaware of the great difficulties involved, and are often incapable of assessing the scientific care required, or the dangers of drawing premature conclusions from the extensive experimental work that is being done.

Warrington Yorke Memorial Fund

THE death of Prof. Warrington Yorke, tragically unexpected by those who knew his vigour and force of character, was a great loss to the Liverpool School of Tropical Medicine and to medicine and biology. His work on the trypanosomes, the nematodes and on other parasitic and tropical diseases earned for him an international reputation, and his later work on the chemotherapy of parasitic diseases was of equal value. It is said of him (*Brit. Med. J.*, April 15) that his introduction of drugs of the diamidine series is making it possible to master kala-azar in places where it is resistant to compounds of antimony, and tribute is paid to his efforts to place British chemotherapy in the front rank. Not only the former colleagues and friends of Warrington Yorke, but also all who respect and admire scientific ability and devoted effort to apply it to the relief of human and animal suffering, will like to know that their admiration may take a practical form. The Council of the Liverpool School of Tropical Medicine is appealing for funds to establish the Chemotherapeutic Research Department of that School as a fitting memorial to Warrington Yorke, who started the work now going on in it. Subscriptions may be sent to the Hon. Treasurer, Warrington Yorke Memorial Fund, Chamber of Commerce, 1 Old Hall Street, Liverpool.

Tattersall Memorial Fund

PAST and present students of the Department of Zoology, University College, Cardiff, have opened a Tattersall Memorial Fund, the object of which is to found a studentship in zoology in the College as a memorial to the late Prof. W. M. Tattersall, who died on October 5, 1943. The organizers of the Fund also desire to invite the many friends of Prof. Tattersall, particularly zoologists, in various parts of the world, to join them in perpetuating his memory.

Information may be had from Mr. G. E. H. Foxon, who is acting as the honorary secretary and treasurer of the Fund, at the Department of Zoology, University College, Newport Road, Cardiff, and to whom donations should be sent.

Earthquakes Registered at Fiji

THE first seismological bulletin has been received from the acting director of the Meteorological Office at Suva (Dr. W. Ralph Dyer). At this station a Milne-Shaw horizontal seismograph has been set up to register north-south movements, the co-ordinates of the station being latitude 18° 08′ 56″ south, longitude 178° 27′ 26″ east. The first earthquake to be recorded officially at this station occurred on July 31, 1943. Thirty earthquakes were registered in August, and up to September 21 twenty-two earthquakes were registered during September. On September 21 the seismograph was temporarily out of action owing to delays in the supply of photographic paper. The initiation of this new station is warmly welcomed. The attention of the Seismological Committee of the British Association for the Advancement of Science to this matter has been mentioned previously in the columns of NATURE, and the new station is also receiving assistance from the Dominion Observatory at Wellington, New Zealand. The Fiji Seismological Station is in an excellent position for the recording of the frequent earthquakes and tremors, a large number of which are submarine, in that Pacific region.

Town and Country Planning Association

THE Town and Country Planning Association will move to the Planning Centre, 28 King Street, Covent Garden, London, W.C.2 on May 8. The new premises provide a room for public meetings (including the Association's fortnightly lunch-time meetings), space for exhibitions and film shows and a meeting room for the Association's members and guests. The Association's library service will be greatly extended and an information service will be made available to deal with all aspects of town and country planning. The Association has arranged an exhibition "The English Town: its Continuity and Development", which is being taken to various parts of England during the next few months, and also an exhibition and film "When We Build Again".

Comet Schaumasse

PROF. H. SHAPLEY reports a telegram received from Strömgren and Lundmark announcing the rediscovery of this comet on March 30. The elements of its orbit and an ephemeris are given in the "Handbook of the British Astronomical Association", 1944. Perihelion passage took place about November 27.

Research into Problems of Hearing and Deafness

BY arrangement with the Medical Research Council, an Otological Research Unit has been established at the National Hospital for Nervous Diseases, Queen Square, London, W.C.1. It is to be maintained jointly by the Council and the Hospital, as in the case of the existing Neurological Research Unit. The director is Dr. C. S. Hallpike, a whole-time member of the Council's scientific staff and aural physician to the Hospital. The Medical Research Council, also, has appointed three new committees to advise and assist in promoting a general programme of research work into problems of deafness. They will deal with the following divisions of the subject. (*a*) Medical and surgical problems of the causation, prevention and treatment of deafness (chairman: Prof. H. Cohen, University of Liverpool). (*b*) Electro-acoustical problems relating to the design and application of instruments used in the investigation and alleviation of deafness (chairman: Dr. W. G. Radley, Post Office Research Station). (*c*) Problems relating to the educational treatment of deafness in children and adults (chairman: Prof. F. C. Bartlett, University of Cambridge). The membership of the committees includes nominees of Government departments and various bodies concerned with the practical questions which are involved.

Birds of Ceylon

MR. P. DERANIYAGALA, director of the National Museums of Ceylon, writes, pointing out that in the obituary notice of Hugh Whistler appearing in NATURE of August 21, 1943, no reference is made to his last major work, the avifaunal survey of Ceylon by the British and Colombo Museums. Whistler worked out the collections, and the results are now being printed in the Colombo Museum journal, *Spolia Zeylanica*; they should be published by about May.

The Night Sky in May

FULL moon occurs on May 8d. 07h. 28m. U.T., and new moon on May 22d. 06h. 12m. The following conjunctions with the moon take place: May 20d. 13h., Mercury 2° N.; May 24d. 04h., Saturn 2° N.; May 27d. 01h., Mars 1° N.; May 28d. 10h., Jupiter 1° S. There is only one occultation during May, and that is of 56 Gemi. on May 25d. 21h. 00·1m. (*D*). Mercury is in inferior conjunction on May 2 and is stationary on May 14. The planet rises about the time of sunrise in the middle of the month and forty minutes before sunrise on May 31. Venus, rising shortly before the sun throughout May, is not very well placed for observation. Mars moves from the constellation of Gemini into Cancer about the middle of May and is visible during the early part of the night. On May 1 the planet sets at 1h. and on May 31 at 23h. 48m. Jupiter is in the constellation of Leo and sets at 2h. 10m. and 0h. 19m. at the beginning and end of May. Saturn, in the constellation of Taurus, is drawing near the sun and sets at 23h. and 21h. 19m. at the beginning and end of the month. The η Aquarids are active during May 1–6 and can be seen in the early morning hours. The radiant is close to R.A. 22h. Dec. $-2°$.

Announcements

SIR JOHN MARSHALL, formerly director-general of archæology in India, has been awarded the Gold Medal of the Royal Asiatic Society.

PROF. W. N. HAWORTH, professor of chemistry in the University of Birmingham, has been elected president of the Chemical Society.

THE Committee on Nutrition Surveys, set up by the English Group of the Nutrition Society, a year ago, has drawn up a list of investigations, recent or in progress, into: (*a*) Consumption of Food; (*b*) Nutritional State; and (*c*) Effect of Supplements on Health and Efficiency. The number is unexpectedly large. A list of these investigations will be sent to anyone working on the subjects, on application to the director, Prof. J. R. Marrack, Advisory Committee on Nutrition Surveys, Bureau of Nutrition Surveys, London Hospital, E.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

The Osmotic Balance

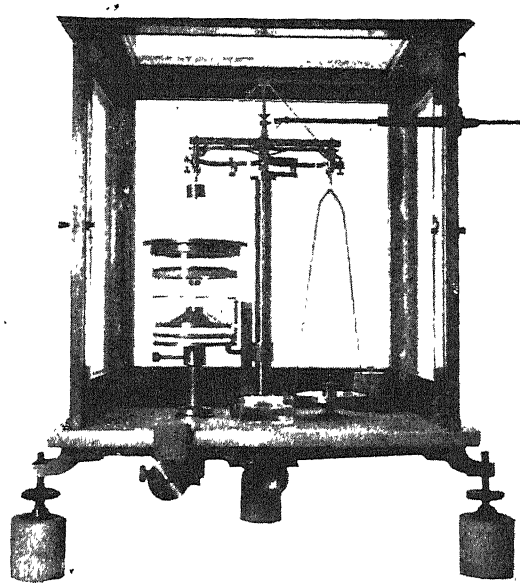
IN the case of polydisperse high polymers, different methods of molecular weight determination give different kinds of average values[1]. The two most important absolute methods are ultra-centrifuging and measurement of osmotic pressure. In the first case one gets, according to the method of calculation used, either weight averages or so-called z-averages, while osmotic pressure measurement always gives number-averages. The knowledge of several different average values for one substance helps us to judge the degree of polydispersity. When dealing with thread-like molecules of high molecular weight, the osmotic measurements are rendered difficult partly by the fact that even comparatively dilute solutions of this type possess high viscosity, partly owing to breakdown of the ideal gas laws at experimentally usable concentrations. One therefore has to resort to a suitable extrapolation procedure for obtaining correct zero-concentration pressure values. These circumstances make it necessary to perform the osmotic measurements at as low concentrations as are experimentally possible.

The methods so far used have aimed at determining the position of a liquid meniscus in a capillary, either by measuring the height of a column at equilibrium[2,3,4], or by applying a variable counter-pressure against the meniscus and measuring its rate of migration at different values of the counter-pressure[5,6].

In order to make it possible to determine lower osmotic pressures than the above-mentioned procedures allow, we have constructed an osmometer, in which the liquid passing through the membrane is weighed. It can be used for osmotic pressures from a few centimetres of water pressure and downwards to some hundredths of a centimetre.

In an undamped analytical balance one of the scales is removed, and on the floor of the balance case is fixed a stand with an adjustable platform carrying a glass cylinder filled with solvent. The osmotic cell is constructed of aluminium and glass, the necessary cementings being made with lead-oxide-glycerine. The lower part of the cell is conical with a basal diameter of 5 cm. At the apex is fixed a glass tube a few centimetres in length and of 0·9 cm. inner diameter. The upper part of the glass tube has an aluminium collar, carrying a wire so that the cell can be hung on the balance arm. A semi-permeable membrane is attached to the base of the conical recipient by means of a threaded ring and a perforated membrane-support. The membrane itself acts as packing material against leakage. The osmotic cell and part of the glass tube is filled with solution and suspended on the balance in such a way that it dips into the solvent contained in the glass cylinder. The whole apparatus is placed in a constant-temperature room.

By means of the adjustable platform the difference in level between the solution in the cell and the solvent in the glass cylinder can be varied. The balance is adjusted to neutral equilibrium. When the weight of the cell increases, the cell sinks until the buoyancy compensates the increased weight. Because of the minuteness of the displacements, the reading of the balance is magnified by means of a beam of light, doubly reflected from a mirror fixed to the balance.



THE OSMOTIC BALANCE.

In order to prevent evaporation, the glass cylinder is provided with a suitable lid perforated in the middle to admit the suspension wire. An open dish with solvent placed inside the balance case delivers solvent vapour to the air, thus diminishing evaporation losses. The creeping of the solvent along the inner wall of the cylinder is prevented by a collar fixed to this wall and filled with solvent. Electrostatic effects, which would disturb the weighing, are eliminated by means of a metal netting placed on the bottom of the cylinder and connected to the lid and to the cell through the suspending wire.

Experiments with the above apparatus have been carried out on nitrocellulose dissolved in butyl acetate. As semi-permeable membrane, 'Ultracellafilter' was used. It takes a considerable time for osmotic equilibrium to be reached and, therefore, a compensation procedure, involving the measurement of the velocity of migration of solvent through the membrane at different levels in the osmometer, was adopted. The osmotic pressure is found by interpolation.

As reference point for the measurement of the difference in levels between solution and solvent is taken the position when the meniscus in the cell is in line with the meniscus in the cylinder. Different adjustments of this position are reproducible to 0·01–0·02 mm. From this starting position all level differences are calculated by means of the corresponding weight differences.

It is necessary to introduce a correction for the rise of the solution owing to surface tension. This is done through null-experiments with solvent both inside and outside the cell.

The following example demonstrates the accuracy obtained so far. The nitrocellulose used as test material was made from American linters and had a nitrogen content of 12·28 per cent. The solvent used was normal butyl acetate, temperature 25° C. The correction for capillary rise was found to be 0·028 and 0·029 cm. in two null-experiments.

Concentration (gm. per 100 gm. solution)	Osmotic pressure (cm. butyl acetate)
0·0501	0·089
0·0500	0·084
0·0500	0·087

Mean, 0·087 cm. butyl acetate.

The corresponding value for the molecular weight (number-average) is 148,000.

The result obtained would indicate an increase in accuracy compared with earlier procedures of a power of ten.

The investigation is being continued and further details will be published elsewhere. Financial support has been received from the following industrial concerns: AB Bofors, Nitroglycerin AB and AB Expressdynamit.

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March 4.

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Organic and Inorganic Pyrophosphates as Shock-inducing Agents

IT was shown by Green[1] and Bielschowsky and Green[2] that injection of the sodium salts of adenosine triphosphate, obtained from Dyckerhoff's "myotoxin", into a variety of animals resulted in a shock-like syndrome. It was suggested that the pyrophosphate group might be responsible for at least some of the described effects.

Further investigations on the striated muscle product show that its adenosine triphosphate is present in the form of the magnesium salt.

It seemed important to analyse the shock-producing action of adenosine triphosphate by a comparison of the action of related compounds varying in the three components: adenosine – polyphosphoric acid – magnesium.

As to the polyphosphoric acid, a detailed study has shown that the injection of $Na_4P_2O_7 . 10H_2O$ does produce effects similar, in some respects at least, to those produced by adenosine triphosphate. To study the influence of the adenosine and magnesium in the molecule, solutions of the sodium and magnesium salts of adenosine triphosphate and inosine triphosphate were tested for their lethal and shock-producing potencies in the rat and mouse, and for their depressor activities in the cat. Both salt solutions were prepared from the corresponding barium salts (barium inosine triphosphate from barium adenosine triphosphate by deamination with sodium nitrite), avoiding excess of magnesium, and their concentrations were checked by estimations of nitrogen and 7 min. phosphorus.

A condensed summary of the results of the assays is given in Table 1, and some abstracted data showing a few of the effects in the whole animal are given in Table 2.

In both the mouse and rat, the lethal doses of the inosine compounds were significantly higher than those of the corresponding adenosine compounds. Some of the shock-inducing effects of the adenosine triphosphate salts are therefore presumably associated with the presence of the amino group of adenosine.

The findings with the sodium salts show that their lethal doses were significantly higher in terms of their pyrophosphate contents than that of sodium pyrophosphate, with the exception of sodium adenosine triphosphate in the mouse. The interpretation of these results is complicated by the fact that the lethal dose of sodium pyrophosphate in the mouse was more than twice that in the rat. In both species the influence of the amino group in the sodium adenosine triphos-

TABLE 1. INTRAPERITONEAL LETHAL AND INTRAVENOUS DEPRESSOR DOSES OF POLYPHOSPHATES (GROUPS OF 6–12 RATS AND 8–16 MICE).

	Mouse			Rat			Cat
Compound	LD_{100} (mgm./100 gm. body wt.)	P_2O_7 content (mgm.)	P_2O_7: P_2O_7—Mag.aden.triphos.	LD_{100} (mgm./100 gm. body wt.)	P_2O_7 content (mgm.)	P_2O_7: P_2O_7—Mag.aden.triphos.	Depressor dose. 30 mm. Hg./kilo body wt. (mgm.)
Magnesium adenosine triphosphate	45	14	1	50	16	1	0·2
Magnesium inosine triphosphate	60	19	1·4	70	22	1·4	4·00
Striated muscle product*	300	26	1·9	340	29	1·9	0·7
Sodium adenosine triphosphate	130	38	2·7	100	29	1·8	0·35
Sodium inosine triphosphate	240	70	5·0	120	35	2·2	—
$Na_4P_2O_7 . 10 H_2O$	120	47	3·4	50	20	1·3	†

* Crude muscle product similar to those from which adenosine triphosphate salts were derived.
† No depressor action except in enormous dosage.

TABLE 2. GENERAL EFFECTS OF MINIMAL LETHAL DOSES OF ADENOSINE AND INOSINE TRIPHOSPHATE IN THE RAT. (AVERAGE OF 4 RATS.)

Compound	Hb (Haldane) per cent, Hours 0	1	4½	Rectal temp. (° C.), Hours 0	1	4½	Respirations per min., Hours 0	1	4½	No. surviving at 4½ hr.
Magnesium adenosine triphosphate	96	110	140	37	25	21	94	51	16	1
Magnesium inosine triphosphate	91	113	122	36	28	26	94	68	70	4
Striated muscle product	102	112	116	36	28	29	103	73	76	4
$Na_4P_2O_7$	93	119	144	37	28	29	93	60	72	2

phate is evident. Nevertheless, the polyphosphoric acid seems to be an important factor since, for example, the lethal dose of muscle adenylic acid is much higher than that of adenosine triphosphate.

The replacement of sodium by magnesium in inosine triphosphate much more than compensates for the loss in activity produced by the substitution of the NH_2 group in the adenosine triphosphate by the OH group (inosine triphosphate). This is shown by comparison of the results obtained with magnesium inosine triphosphate and the sodium salts of adenosine triphosphate and inosine triphosphate (Table 1).

It may be assumed, therefore, that the P_2O_7 group becomes biologically more active, at any rate so far as its shock-producing effects are concerned, when it is combined with both magnesium and either adenylic or inosinic acids. As we have been unable so far to prepare an inorganic magnesium polyphosphate suitable for injection, we do not yet know whether this is due to the influence of the magnesium ion on the polyphosphoric acid group.

The magnesium salt of adenosine triphosphate had the greatest potency of all the substances tested, and using minimal lethal doses a shock-like condition followed the injection much more rapidly (Table 2). It is noteworthy that the quotient P_2O_7/P_2O_7—magnesium adenosine triphosphate is the same in both species for magnesium adenosine triphosphate, magnesium inosine triphosphate and the striated muscle product (Table 1), whereas there is a considerable difference between the rat and mouse in the quotients for both sodium adenosine triphosphate and sodium inosine triphosphate. A calculation on the basis that all the adenosine triphosphate in the striated muscle product is present as the magnesium salt accounts fully for its vaso-depressor activity (see Table 1). Its lower shock-producing potency after intraperitoneal injection is probably due to a slower rate of absorption of the magnesium adenosine triphosphate from the crude muscle product. All the data at our disposal make it highly probable that the adenosine triphosphate in striated muscle is present in the form of the magnesium salt. This conception is in good agreement with the results obtained by Szent-Györgyi and his collaborators[3].

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Reaction between Proteins and Formaldehyde

IT has been found possible to deamide animal and plant caseins by treatment with a solution of 1 per cent caustic soda for 40 hr. at 45° C. The desamido casein, when hardened with formaldehyde under neutral conditions, combines with the same amount of formaldehyde as does the untreated casein. In the presence of salts, acids (for example, saturated calcium chloride solution and hydrochloric acid) and formaldehyde, the neutral hardened deamided material combines with no additional formaldehyde, whereas the untreated neutral hardened casein may increase its formaldehyde content by about 100 per cent.

Partial deamination is also possible without the removal of amide nitrogen. The partially deaminated product combines with a reduced quantity of formaldehyde under neutral conditions. In contrast to this, the same partially deaminated product combines with a normal quantity of additional formaldehyde when treated with formaldehyde, salt and acid.

Further confirmation of the conception of a reaction between formaldehyde and the amide groups of proteins is given by experiments with the protein zein. Only 0·4 per cent of formaldehyde combines with this protein when it is hardened in a neutral solution. In the presence of salt and acid, however, its combined formaldehyde increases to 4·1 per cent. These figures are in keeping with the low amino and high amide contents of zein.

It is concluded, therefore, that at or near the isoelectric point of the protein, formaldehyde combines with the amino groups mainly derived from lysine residues. Under more acid conditions it combines with the amide groups which are attached to residues of glutamic and related acids. A more detailed account of the investigation will appear elsewhere.

We thank the directors of Messrs. Courtaulds, Ltd. for permission to publish this communication.

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March 24.

Methionine in the Treatment of Liver Damage

RECENT investigations on protein metabolism and nutrition have increasingly emphasized the importance of individual amino-acid deficiencies in producing specific clinical states and pathological appearances[1]. It has been shown[2] that fatty livers can be produced in rats by dietary control. This latter work, and the findings of Miller and Whipple[3] that methionine could protect the liver against damage by chloroform, suggested to us that the present epidemic of infective hepatitis and the increased incidence of 'post-arsphenamine' jaundice might in some measure be conditioned by a sub-optimal protein intake leading to a latent methionine deficiency.

In 1942 we commenced a series of investigations along three main lines: (*a*) the prevention of liver damage during arsenical treatment for syphilis; (*b*) the treatment of established liver damage in cases of infective hepatitis and 'post-arsphenamine' jaundice; and (*c*) the treatment of patients gravely ill with liver dysfunction extending over a period of many weeks or months. Our observations in the prevention of liver damage during arsenical treatment, to be published in detail shortly, have made it abundantly clear that liver damage can either be prevented or minimized by the administration of methionine or by the use of casein digests rich in methionine which have had cystine added to them. The addition of cystine apparently was of value because of the methionine-sparing action of the cystine.

Owing to the extremely variable severity of infective hepatitis and of 'post-arsphenamine' jaundice, the value of any treatment or treatments can only be appraised statistically and after many hundreds of cases have passed through our wards. So far, pre-

liminary results based on a study of 450 cases, including controls, would appear to show that the clinical course of the above diseases is influenced beneficially, and the period in hospital significantly shortened, by treatment either with pure methionine in properly regulated dosage or by feeding patients with rapidly absorbable casein digests rich in methionine. In gravely ill patients, the results obtained by methionine treatment have been so striking as to leave no doubt as to the efficiency of the treatment, especially in those cases which have remained jaundiced for weeks or months and were in a state of *icterus gravis* when methionine treatment was initiated.

All our work has convinced us of the importance of an adequate protein intake, and more specifically of those proteins rich in methionine, in preventing and treating liver damage due to widely differing causes. We can therefore substantiate in large measure many of the suggestions put forward by Himsworth and Glynn[4] as a result of their experimental work on rats.

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Effect of Vitamin C on the Adrenaline Content of the Adrenal Glands of Guinea Pigs

I HAVE shown[1] that the insulin content of the pancreas is markedly diminished in scurvy. This may be due to a lowered vitality of all the tissues of the scorbutic animals or to the existence of a specific relation between vitamin C and the insulin content of the pancreas. As is known, the adrenal glands are concerned in carbohydrate metabolism. The adrenaline content of the adrenal glands was, therefore, studied in scorbutic and normal guinea pigs.

Guinea pigs on a scorbutic diet for 22–25 days, and guinea pigs fed with normal diet for 15 days, were starved overnight and the adrenal glands were removed next morning. The adrenal glands were extracted with trichloracetic acid for adrenaline and ascorbic acid according to the method of Rees[3]. This method was adopted as the value of adrenaline thus determined in adrenal gland extracts was found to correspond to that determined biologically. The results are summarized in Table 1 and the statistical analyses of the individual figures are given in Table 2.

TABLE 1.

	No. of animals	Average weight per animal	Weight of adrenal per 100 gm. body wt.	Ascorbic acid per gm. of adrenal	Adrenaline per gm. of adrenal	Adrenaline per pair of adrenals
Scorbutic guinea pigs ..	21	339 gm.	100·0 mgm.	0·035 mgm.	719·2 μgm.	223 μgm.
Normal guinea pigs ..	20	315	61·2	1·002	353·8	66

TABLE 2.

	Wt. of adrenal per 100 gm. of body wt.	Ascorbic acid per gm. of adrenal	Adrenaline per gm. of adrenal
Difference of the means	38·8 mgm.	0·967 mgm.	365·4 μgm.
Standard error of difference	6·187	0·13078	74·66
t	6·27	7·39	4·89
Remarks	Highly significant	Highly significant	Highly significant

The results show a highly significant increase in the adrenaline content of the adrenal glands in scurvy as opposed to the decrease in the insulin content of the pancreas[1]. The diminished insulin content of the pancreas of the scorbutic guinea pigs is, therefore, not merely due to the lowered vitality of the tissues of the animals. The action of vitamin C on the secretion of insulin appears to be specific in some degree, as the insulin content of the pancreas is not altered in vitamin B_1-deficiency[4], which also affects carbohydrate metabolism.

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White Plumage of Sea-Birds

IN a recent communication[1] on this subject, Craik makes some suggestions which we have attempted to examine further. A simple experiment in which conditions natural to fish were imitated was made on the flat roof of the Zoology Building here. The observer looked vertically upwards through a glass trough filled with water at a piece of opaque cardboard 3 in. × 5 in. in size held 6 ft. above his head. The agitation of the water by the wind made visibility of details very poor. With any overcast sky, when the observer was presented successively with a black and a white piece of cardboard, he was unable to tell which was which. But when the sun was shining on them, the white cardboard was at once distinguished from the black.

Now it can be calculated that when the sky is overcast the brightness of a horizontal white surface illuminated by the light reflected from the sea is of the order of only a tenth of the brightness of the sky (the reflexion factor of water is 0·02 for normal incidence). Its contrast against the sky will thus be about 0·9, as compared to 1·0 for a perfectly black object. At close range the horizontal parts of a white bird or aircraft must therefore be expected to appear (like the white cardboard) very dark against the sky. The difference of contrast just mentioned can, however, affect the critical range of visibility. The light scattered by the air-layer between the eye and an aeroplane will decrease the contrast between the latter and the sky. The intensity of scattered light needed to reduce the contrast from the value at close range to the smallest contrast perceptible by man (of the order of 0·01) is 0·89 for a white object and 0·99 for a black object. If the intensity of the scattered light is proportional to the distance, one would thus expect the range at which they became invisible to be about 10 per cent shorter for white than for black aircraft. We have assumed here that the critical factor affecting visibility is intensity discrimination, that is, the retinal image is large and the value of the differential threshold is not dependent on its size. But as the range

of vision of fish is believed to be small, their threshold of visibility will scarcely be affected by atmospheric scattering and cannot depend only upon intensity discrimination as such. However, as Dr. Craik pointed out in discussion, when atmospheric scattering is negligible, the range of visibility of a white object will still be smaller than that of a black one. An object will become invisible when it is so far away that its image on the retina reaches a certain minimum size for any given brightness. If the threshold of visibility is a function of the product area by contrast only, then since area decreases as the reciprocal of the square of the distance, the difference in range should now be about half as great as it was for intensity discrimination alone. But the contrast to be taken into consideration here is the average contrast (say 0·8) of the object, rather than the contrast of the darker parts. The difference between the critical ranges of visibility of black and white objects will thus be again of the order of 10 per cent. It may be pointed out, however, that a black bird 10 per cent smaller in linear dimensions than a white bird would become invisible at the same range as the latter.

When the sky is clear, the situation is different. If direct sunlight strikes the white plumage of a bird, the latter will acquire a brightness of the order of 25,000 candles/m.^{2} (the sun giving an illumination of 100,000 lux)[2]. This brightness is much above that of blue sky, which is stated to be[3] 4,000 candles/m.^{2}. This agrees with what we observed in our experiment. In sunshine, white birds may therefore be very conspicuous to fish, and if anything more so than black.

It is therefore not clear that white birds are on the whole less easily seen than others, and in this way stand at an advantage. A closer analysis of the problem from the fish's point of view shows how complex it really is. For example, as the surface of the sea is generally agitated, it is not certain what a marine fish does see of objects in the air. Ward's[4] observations suggest that they would see very little. There are at the edges of the 'window' in the area of total reflexion dark ripples which may well be confused with birds. This casts doubt upon the implicit assumption on which the above calculations are based, namely, that the fish take action as soon as the bird becomes visible. Definite information is needed about the actual stimuli which make fish dive.

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Zoological Laboratory,
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March 23.

[1] Craik, K. J. W., NATURE, 153, 288 (1944).

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As Pirenne and Crombie have pointed out above, scattered light can, in the long ranges at which aircraft are spotted, have an effect on contrast which is not present at short ranges, but calculations for short ranges show that one might expect a considerable difference in spotting range for black and white birds. A considerable part of the brightness of a roughly hemispherical object such as a bird, seen from below with overcast sky, is contributed by skylight and not by light reflected from the sea. Estimating the reflexion factor of the bird's plumage at 0·9, this would make the mean brightness of the underside about 0·15 of that of the cloud background. This should have a definite effect on maximum spotting range, for at the human threshold, in clear air, the visibility of an object of high contrast is determined mainly by the total reduction in incident light or 'subtractive energy', that is, the contrast multiplied by the angular area. Thus an object of half the background brightness will require to have about twice the area, or to be brought to about $1/\sqrt{2}$ of the distance, to be visible. The same is likely to apply to fish (though their absolute visual acuity is poorer); and for objects blurred, as Pirenne and Crombie point out the image of the bird will be, by surface ripples. On this basis, a contrast of 0·85 should produce a 7 per cent reduction in spotting range, which is of the same order as that to be expected with aircraft. Further, the conditions of cloudless blue sky, under which the bird will be brighter than the sky, are rather rare in temperate climates and there will be other conditions, such as sun shining through breaks in cloud, in which the brightness of the bird may exactly equal that of the background.

Rough experiments with paper disks on white backgrounds confirm this, particularly for peripheral vision, in which human acuity is poorer and perhaps approximates more closely to that of fish. To exaggerate the contrast very slightly, and thus obtain definite results with relatively few readings, punched paper disks of dead black and grey paper 5 mm. in diameter were mounted on white card, giving measured contrasts of virtually 1·0 and of 0·75. They were viewed at 15° from the visual axis, at the following distances. A blank card was sometimes presented, and the number of times when the observer failed to report the presence of a spot was recorded; he took about 5 sec. to judge.

	Grey spot	Black spot	No spot
Observer A			
Errors at 4·2 m.	17/20	1/20	0/20
Errors at 3·75 m. (— 10%) ..	11/20	0/20	0/20
Errors at 3·4 m. (— 20%) ..	1/20	—	0/20
Observer B			
Errors at 3·8 m.	15/20	2/20	2/20
Errors at 3·4 m. (— 10%) ..	5/20	—	0/20
Errors at 3·0 m. (— 20%) ..	1/20	—	0/20

Thus the errors at the longer distance are markedly greater with the grey than with the black spot, and when the distance is reduced the errors on the grey disk decrease, equalling at somewhere between 10 and 20 per cent shorter range those obtained with the black disk at full range. This is in good agreement with the above theory, on which the reduction for this contrast should be $1-\sqrt{0\cdot75}$ or 13 per cent. Thus there should be some advantage in white plumage if fish dive as soon as the bird reaches threshold visibility, but I agree that whether in fact they do so should, if possible, be directly investigated.

K. J. W. CRAIK.

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DR. K. J. W. CRAIK's suggestion[1] that the white coloration of sea-birds is adaptive in the sense of rendering them less conspicuous to their prospective victims cannot be considered convincing in view of the following difficulties.

A by no means negligible number of predomin-

antly white sea-birds, among them some albatrosses and shearwaters, do not feed mainly on living fish, but on organisms not endowed with sufficiently long sight for the coloration of the bird predator to be of importance. Some of these birds feed chiefly by night, when white coloration is not of any obvious advantage. Gulls are primarily scavengers.

It is difficult to believe that dark coloration would be a disadvantage to such a bird as a gannet plunging almost vertically at high speed on its prey. There is no evidence that gannets or boobies in immature brown plumage are thereby handicapped in catching fish. The same may be said of the dark-plumaged immature sooty terns.

Diving birds which hunt fish are not infrequently brilliantly coloured or dark—both those which dive from a perch or hovering position, such as kingfishers, or others, such as guillemots, mergansers and cormorants, which dive from the surface of the water.

The white coloration of some large birds, such as swans, appears to be related to their relative immunity from predators and not to feeding habits.

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[1] NATURE, 153, 288 (1944).

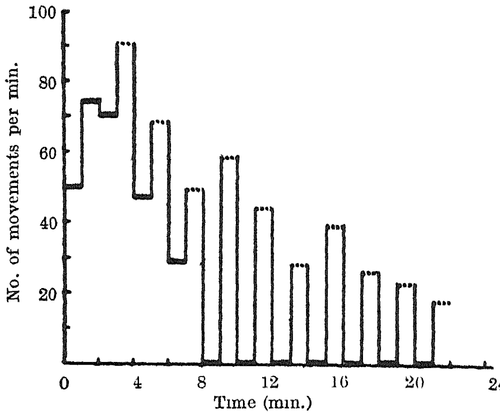
Immediate Effect of X-Rays on the Movements of Larvæ and Pupæ of Mosquitoes

DURING X-ray experiments with larvæ and pupæ of mosquitoes (Culex), irradiated specimens were observed to accelerate their movements immediately after the onset of irradiation. When the irradiation is interrupted, they return at once to normal behaviour. Since we could find no description of the phenomenon, we attempted to study it in detail, as it appeared to constitute an immediate reaction to X-rays.

Larvæ and pupæ of the mosquito *Aedes ægypti* were used, because they were available in numbers, and their movements can be readily counted. The number of movements per minute was taken as a measure of activity. In order to determine the activity of the larvæ and pupæ under normal conditions, their movements were counted during three consecutive minutes before the beginning of irradiation. This number varies in different individuals from 30 to 80 per minute. The individuals were then subjected to successive irradiations of one minute, alternating with interruptions of the same duration. One larva or pupa at a time was exposed to irradiation in hollow slides filled with water, the diameter of the hollow being 9 mm. Throughout each experiment the specimen remained in position under the X-ray tube, the interruptions of the treatment being effected by closing the X-ray exit with a lead shutter.

A demountable tube was used as X-ray source. The anticathode consists of copper and the exit of the rays is closed by a thin aluminium sheet 30 μ in thickness. The tube was operated with a tension of about 35 kV. max. and a current of 10 m. amp., the intensity being 38,000 r./min., the irradiated specimen being 38 mm. from the anticathode. The characteristic course of the experiments is shown in the accompanying graph. The activity during irradiations and interruptions was determined as described above.

The difference in activity during irradiations and



Activity of a pupa of *Aedes ægypti*

breaks is clearly seen. Activity is distinctly increased during irradiation by 20–60 movements per minute. As the experiment progresses the activity diminishes and finally ceases entirely during the breaks, whereas during the irradiation the specimen continues to move actively for a period of about half an hour and even more. Different individuals may react differently to the irradiation with regard to both rate of movement and time of cessation, but the general course of the experiment is uniform.

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Cultures of Excised Leguminous Roots

WITH the development by White, Robbins, Bonner and others of a technique permitting the culture of root systems from excised root tips, the possibility arose that the method might profitably be employed in studies of leguminous root nodules. Certainly if it proved possible to secure nodule formation on root cultures, then the investigation of some problems associated with the symbiosis between legume and nodule organism would be facilitated. So far as I am aware, there has been only one published record of an attempt to secure the nodulation of excised leguminous roots, namely, that of Lewis and McCoy[1]. Working with excised bean roots growing in agar, they observed the development of four nodules upon one root out of sixty that were cultured.

I have investigated the possibility of inducing the formation of nodules on excised roots of maple pea (Pisum). Excellent growth of roots of this species has been obtained in the medium formulated by Bonner[2], which includes inorganic nutrients, sucrose, vitamin B_1 and nicotinic acid. The procedure adopted is to germinate surface-sterilized and imbibed seeds of maple pea on agar plates until the radicles are 1–2 cm. long. Tips 0·5 cm. in length are then excised and transferred to flasks containing a shallow layer of the sterile nutrient solution. From such tips, roots 10–12 cm. long have developed within two weeks, while after longer periods roots up to 40 cm. in length have been obtained, well supplied with laterals, without any renewal of the medium. The roots bear short root-hairs, but as noted by Bonner[3], no secondary thickening has been observed.

The inoculation, with appropriate nodule bacteria, of excised pea roots growing in the above culture solution has not resulted in nodule formation. The organisms multiply in the medium, forming slimy strands adhering to the root surface, but the brief microscopic observations so far made reveal no curvature or primary infection of the root hairs. This last point obviously deserves much fuller investigation.

It seemed possible that the nitrate of the Bonner medium might be exerting an inhibiting effect, since it is well known that the presence of combined nitrogen tends to reduce the extent of nodulation of a leguminous plant. Initial reduction of the level of nitrate, however, markedly reduces the growth of the excised roots themselves. The method was therefore adopted of transferring well-grown roots into a medium with reduced nitrate and then inoculating. Control roots remained healthy and showed some growth, but no nodules developed in the inoculated cultures. It was also observed that good nodulation can be secured on 'whole plant' cultures of pea growing with their roots immersed in the Bonner medium with full nitrate (no sucrose).

Attention has also been given to the possible effect of the sucrose content (4 per cent) of the Bonner medium. Tests carried out under aseptic conditions with whole pea plants growing in nutrient agar or in sand watered with the nutrient solution suggest that this concentration of sugar interferes with nodule formation (see table).

Concentration of sucrose (per cent)	4	3	2	1	0·5	0·1
Average number nodules per plant	1·2	3·2	4·0	6·2	12·5	16·3

The excised roots, however, require the 4 per cent concentration for vigorous development, a reduction even to the 3 per cent level leading to lessened growth. Well-grown roots were transferred to solutions low in sucrose before inoculation, but although the bacteria survived and multiplied, no nodules were formed.

It is obviously a possibility that the Bonner medium, though providing all requisite factors for primary growth, is short of some accessory factor necessary for nodule formation. In the intact plant this factor may pass down from the stem and leaves[4], although it may be noted here that in pea the current incidence of light upon the shoot does not appear to be necessary for nodule formation, since I have observed as many as 26 nodules per plant on fully etiolated plants rooted in agar[4,5]. Experiments in which top extracts have been added to inoculated excised roots have not resulted in nodulation. The findings of Wipf and Cooper[6] may be of significance in these attempts to secure nodulation on excised roots, which were no more successful with excised roots growing in agar media.

The above investigations (now interrupted) followed some preliminary work by Miss Helen Fraser, and were carried out during the tenure of a Robert Donaldson Research Scholarship under the direction of Dr. G. Bond, who also gave assistance in the preparation of this preliminary account.

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Feb. 26.

[1] Lewis, K. H., and McCoy, E., *Bot. Gaz.*, **95**, 316 (1933–34).
[2] Bonner, J., and Devirian, P. S., *Amer. J. Bot.*, **26**, 661 (1939).
[3] Bonner, J., *Amer. J. Bot.*, **27**, 692 (1940).
[4] Thornton, H. G., *Proc. Roy. Soc.*, B, **106**, 110 (1930).
[5] Wilson, J. K., *Phytopath.*, **21**, 1083 (1931).
[6] Wipf, L., and Cooper, D. C., *Amer. J. Bot.*, **27**, 821 (1940).

Absorption in the Atmosphere and Decay of Cosmic Rays

IN a former communication[1], an account was given of the hourly records of cosmic-ray intensity which are being made in London by registering threefold coincidences between three trays of Geiger-Müller counters without using any absorbing screen. The full description of the apparatus is given elsewhere, together with a complete account of the analysis of the data corresponding to the first few months of observation.

For the first part of this analysis, the hourly numbers of cosmic particles averaged in groups of 24 hours were correlated with the barograph readings at the station averaged over the same intervals. The correlation coefficient thus obtained has the high value $-0·87$, and the barometric coefficient β represented by the slope of the corresponding regression line is $\beta = 3·45$ per cent per cm. mercury, or $2·53 \times 10^{-3}$ cm.^{2}/gm. This value of β is consistent with those formerly found by counter measurements, although greater in general than the value obtained with ionization chambers.

The principal object, however, of this provisional analysis of our data has been to separate the effects of absorption and decay which, on the hypothesis of the instability of the hard component, together determine the barometric coefficient. This separation has been made by establishing that the variation of the number N of cosmic particles at ground-level is a function first of the variation of the air mass (represented by the barograph reading B at the station) and secondly of the change in height $H - H_m$ of the pressure-level at which mesons are generated; this function is expressed by the equation

$$N - N_m = \mu(B - B_m) + \mu'(H - H_m),$$

where the subscript m refers to mean values. Clearly, μ represents the true absorption coefficient in air, and μ' the mean rate of decay of mesons.

We do not know the pressure at which mesons are formed; but it is possible to ascertain what would be the most likely pressure between 760 mm. and 75 mm., the heights of which can be found from meteorological observations. This can be ascertained by comparing the *partial* correlations $R_{NH,B}$, that is, the correlations for B constant, between the mean daily number of cosmic rays at ground-level and the heights corresponding to different pressure-levels for the same days. The accompanying table gives the values of $R_{NH,B}$ for the pressure-levels which have been chosen. Only the mean daily numbers of cosmic rays corresponding to days for which the meteorological data from the ground up to 16 km. were complete (80 in all) have been used, so that the values of $R_{NH,B}$ should be entirely comparable.

Pressure level	$R_{NH,B}$
75 mm. (16·1 km.)	$-0·67$
113 mm. (13·5 km.)	$-0·54$
188 mm. (10·3 km.)	$-0·32$
375 mm. (5·5 km.)	$-0·30$

The gradual increase of $R_{NH,B}$ with height, as shown by the table, seems to indicate that the appropriate pressure-level to be used in the equation is 16 km. or higher. On the other hand, the great significance of the value $-0·67$ for the corresponding correlation justifies the presence of the second term on the right-hand side of the equation, thus confirm-

ing the view that a part of the variation of the cosmic ray intensity at ground-level may be explained by spontaneous disintegration of mesons in the atmosphere.

The increase of the correlation with height does not imply, of course, that mesons are formed at the layer of 75 mm. pressure. They may be generated at higher layers, as suggested by the experiment of Schein, Jesse and Wollan[2]; but we can substitute for $H - H_m$ in the equation the fluctuations in height corresponding to 75 mm. pressure and thus obtain a first approximation to the regression coefficients. By so doing, and by applying the method of least squares, we obtain for the coefficient of true absorption :

$$\mu = 2 \cdot 28 \text{ per cent per cm. mercury, or } 1 \cdot 68 \times 10^{-3} \text{ cm.}^2/\text{gm.}$$

Ehmert[3] has measured the absorption curve in water and shown that the absorption coefficient down to a depth of 45 m. is given by the formula $\mu = 1 \cdot 56/h$, where h is the depth in gm./cm.^{2} On the other hand, from the theoretical results obtained by Rossi and Greisen[4] for the range of mesons in air, iron and lead, we have estimated that the ratio of the range in water to that in air would be about 0·9 for mesons of energy not greater than 10^9 eV. Assuming that Ehmert's formula is valid for air, and by applying the latter ratio to obtain the mass of water equivalent to the mass of air (thickness of the roof and counter-box included) above our apparatus, we obtain $\mu = 1 \cdot 65 \times 10^{-3}$ cm.^{2}/gm., which is nearly the same as that obtained from our observations.

For the second regression coefficient or mean rate of decay of the meson we obtain
$\mu' = 0 \cdot 054$ per km., or $0 \cdot 94 \times 10^{-3}$ cm.^{2}/gm.

Kolhörster and Matthes[5], by registering double coincidences while compensating for the variation of atmospheric pressure with a variable wood screen, have found for μ' the value $1 \cdot 15 \times 10^{-3}$ cm.^{2}/gm., which is of the same order. Taking into account, however, that no absorbers are used in our arrangement, allowance should be made for the amount of soft component which is recorded by the apparatus, and therefore the actual value of μ' should be greater.

For the mean range of the meson before disintegration, we have

$$L = \frac{1}{\mu'} = 18 \cdot 6 \text{ km.}$$

The mean life when at rest of a meson of 3×10^9 eV. energy would be $\tau_0 = 1 \cdot 6 \times 10^{-6}$ sec.

As to the temperature effect α, its value can also be obtained immediately by making use of Blackett's expression[6] $\alpha = - \delta z/L\delta\theta$. From meteorological data, $\delta z/\delta\theta = 0 \cdot 065$ km., for $z = 16$ km.; hence

$$\alpha = - 0 \cdot 35 \text{ per cent per } ^\circ\text{C.}$$

This value is greater than that generally found, but this was to be expected since α has been usually referred to the temperature near the ground.

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[1] Duperier, NATURE, 149, 579 (1942).
[2] Schein, Jesse and Wollan, *Phys. Rev.*, 59, 615 (1941).
[3] Ehmert, *Z. Phys.*, 106, 751 (1937).
[4] Rossi and Greisen, *Rev. Mod. Phys.*, 13, 240 (1941).
[5] Kolhörster and Matthes, *Physik. Z.*, 40, 142 (1939).
[6] Blackett, *Phys. Rev.*, 54, 973 (1938).

Roozeboom's Type II of Solid Solution

ON p. 20 of Jänecke's "Kurzgefasstes Handbuch aller Legierungen" (Leipzig: Spamer, 1937), there is the following statement: "Es wurde früher vielfach noch ein Typus vollständiger Isomorphie angenommen, bei dem Schmelzpunkt-maximum auftreten sollte, obwohl hierfür niemals ein Beispiel gefunden war und auch schon von langen Jahren van Laar durch thermodynamische Betrachtungen nachgewiesen hatte, dass ein solcher Typus nicht auftreten könnte. Er wurde aber noch von Roozeboom angenommen, wodurch sich diese Auffassung noch in verschiedenen Lehrbüchern erhalten hat".

Early in 1939, I wrote to Prof. Jänecke (to whom I am personally unknown), asking him how he accounted for the existence of an apparent confirmation of this type in the well-known system *d*- and *l*-carvoxime (Adriani, *Z. physikal. Chem.*, 33, 469; 1900). The following is Prof. Jänecke's reply, dated April 24, 1939. "Das bekannte System: *d*- und *l*-Carvoxim und das neue: Malonsäure (—) monobornylester und M(+) ester ist kein Widerspruch mit dem von mir auf S.20 meines Buches gemachten Behauptungen. Es handelt sich in diesen Fällen ausgesprochenerweise um eine Verbindung, die beiderseits Mischkrystalle bildet. Es bilden sich entweder Mischkrystalle von $(d - l)$ mit d oder mit l. Die Darstellung zerlegt sich in zwei Teile. Vermutlich wurden sich bei organischen optisch aktiven Stoffen noch mehr Beispiele finden. Anderseits wird sich der Fall auf diese [word undecipherable] Verbindungen beschränken. In dem Nachtrag zu meinem Buche der Ende dieses Jahres erscheinen soll, werde ich hierauf noch kurz eingehen".

The reference to van Laar appears to be *Z. physikal. Chem.*, 63, 216–253 (1908), the crux of the matter occurring on pp. 235–236. Van Laar deduces the inequality :

$$(\alpha_2 - \alpha_2') < q_2 . \frac{T_1 - T_2}{T_2}$$

as the determining condition for a falling equilibrium temperature. T_1 and T_2 are the absolute melting points of the pure components, T_1 being the higher: q_2 is the heat of fusion of the lower melting component: α_2 and α_2' are constants determining the differential heats of mixing of the low melting component in the liquid and solid phases respectively. From here on I use van Laar's own words: "Ist nun $T_1 > T_2$ so ist das zweite Glied dieser Ungleichung immer positiv. Das erste Glied wird jedoch stets negativ sein, da die Grösse α_2' (welche die Mischungswarme in der festen Phase bedingt) in allen normalen Fällen $> \alpha_2$ in der flüssigen Phase ist. Die obige Ungleichung wird somit sicherlich stets erfüllt sein, so dass die Schmelzcurve wohl niemals bei der höchsten Schmelztemperatur zu steigen anfängt, und ein Maximum folglich so gut wie ausgeschlossen ist." I add that van Laar's demonstration is not, like many of the demonstrations of the Dutch school, dependent on van der Waals' theories of state.

The matter is of some importance, since many text-books of physical chemistry, including one with which I am myself associated, includes the erroneous diagram.

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RESEARCH ITEMS

Antibiotics from *Aspergillus fumigatus*: Identity of Helvolic Acid and Fumigacin

The mould *Aspergillus fumigatus* gives rise to no fewer than four crystalline metabolic products possessing antibacterial activity. Of these, two compounds, fumigatin and spinulosin, have been definitely characterized and identified (Anslow and Raistrick, *Biochem. J.*, 32, 687 and 2288; 1938; Oxford and Raistrick, *Chem. and Ind.*, 61, 128; 1942). They are, in fact, closely related and have the constitutions 3-hydroxy-4-methoxy-2 : 5-toluquinone and 3 : 6-di-hydroxy-4-methoxy-2 : 5-toluquinone, respectively. A third product, helvolic acid, m.p. 204·5–212°, was isolated from *A. fumigatus* mut. *helvola* and described by Chain, Florey, Jennings and Williams (*Brit. J. Exp. Path.*, 24, 108; 1943). It is nitrogen free and has the empirical formula $C_{32}H_{44}O_8$ (deduced from ultimate analysis and X-ray mol. wt. data) and forms a monomethyl ester. Nothing further is known as to its constitution, but the substance is stated to be relatively non-toxic to animals, although active against Gram-positive organisms, for example, *Staphylococcus aureus* at 1 : 80,000, complete inhibition. Prior to this discovery another antibiotic from *A. fumigatus* was described by Waksman, Horning and Spencer (*Science*, 96, 202; 1942; *J. Bact.*, 45, 233; 1943) and was given the name fumigacin. It was stated to have a melting point of 185–187°, to contain 3·7 per cent of nitrogen and to be active against Gram-positive bacteria. In a forthcoming issue of *Science*, Waksman states that Menzel, Wintersteiner and Hoogerheide have demonstrated that fumigacin as prepared by Waksman contains some 20 per cent of gliotoxin, $C_{13}H_{14}N_2O_4S_2$, an antibiotic from *Gliocladium fimbriatum* and toxic to animals (Johnson, Bruce and Dutcher, *J. Amer. Chem. Soc.*, 65, 2005; 1943). On removal of the gliotoxin fraction, the purified fumigacin was found to be identical with helvolic acid in chemical composition, antibacterial activity and *in vivo* activity. The antibacterial metabolic products of *A. fumigatus* so far identified are therefore fumigatin, spinulosin, helvolic acid (or purified fumigacin) and gliotoxin.

Termites and Soil Fertility

A. M. Adamson, of the Imperial College of Tropical Agriculture, Trinidad, has discussed the relation of termites to soil fertility (*Trop. Agric.*, 20, 107; 1943). The most important of the activities of termites, in so far as they bear upon soil fertility, are probably: (1) consumption of dead wood and other plant remains, thereby accelerating the formation of humus; (2) movement of soil above the surface, for building nests and covered passages, thereby exposing the soil to weathering and promoting its admixture with humus; (3) making subterranean tunnels, which are exceedingly abundant and promote aeration, drainage and root penetration. In dry areas of sparse vegetation, the amount of organic matter in the soil may be seriously reduced if too many termites are present, but it is a subject which does not seem to have been investigated. Harvester termites attacking grasses denude parts of the velds of Africa, causing erosion. Much research, however, is necessary to elucidate the relations between soil fertility and the incidence of termites. Much work is also required on the composition of the materials forming the termitaria or habitations of these insects, and on their feeding habits in relation to organic matter in the soil. It is noteworthy that as regards their mode of life the termites fall into two natural groups. First, those of the family Kalotermitidæ, which live almost exclusively within dead wood. Their only activities affecting soil fertility are the consumption and disintegration of such material. The second group comprises the remaining families of the termites. Their members spend almost all their lives in intimate contact with the soil, and all of them apparently influence it in one way or another.

Laboratory Strains

R. Lamy (*Proc. Roy. Soc. Edin.*, 62, 9; 1943) has discovered an interesting divergence in the genotypes of different strains of *Drosophila pseudo-obscura*. This sheds some light on the validity of laboratory experiments for the solution of problems in the wild. She shows that backcrosses between Race *A* with marked *X*-chromosomes, and Race *B* of this species, sometimes exhibit non-viability of one or both sexes. Different strains differ in this reaction with a wild strain. The non-viability is greatly influenced by other genes on the autosomes. This divergence appears to be correlated with the length of time the strains have remained in isolation. The author suggests that the presence of a major gene in a strain may alter the selective value of many subsidiary genes, and this in turn would lead to a directional drift of the genotype as a whole. As a consequence, different strains containing one or more primary gene differences from another would be expected to diverge more and more from the original type.

Genetics of *Papaver alpinum*

A valuable analysis of the taxonomy, genetics and distribution of the group *Papaver alpinum* has been made by A. C. Fabergé (*J. Genetics*, 45, 139; 1943). This aggregate species has a more restricted range than *P. nudicale* but exhibits a considerable number of variants in the wild. These correspond to characters which are unifactorial in inheritance in cultivated *P. alpinum*. A diagnostic key and a distribution map are given by the author, who discusses the possible evolution of the group. The Sewell-Wright effect of random genefixation would appear to play a large part in the creation of a population uniform for apparently non-selectable characters. These populations may be relics. Eleven genes are identified. One locus has three allelomorphs. Linkage tests show the existence of two linkage groups, of which one has five loci and the other three loci. In the first group, covering seventy units, there is little interference, which is similar to the reported data in *Primula sinensis* and Zea and rather different from Drosophila.

Mosaic Disease and Fruiting of the Tomato

Reduction in the yield of tomato plants infected with mosaic virus has been described by several authors. A more detailed investigation has recently been made by Ireson W. Selman (*J. Pomol. and Hort. Sci.*, 20, Nos. 3 and 4, Oct. 1943). Mosaic-infected and healthy plants were studied at two levels of liming and three levels of potash manuring. The total number of flower buds per plant was not affected by mosaic infection, but was reduced by liming and the addition of potash. Total numbers of fruits were,

however, reduced by mosaic infection and by liming, but were unaffected by the level of potash. An interesting fact is that liming, potash manuring and mosaic infection all depressed the yield of fruit, suggesting that the tomato crop is not benefited by excessive manuring. This conclusion has recently been reinforced from other directions. Mosaic infection reduced the yield of fruit at all levels of lime and potash, and also increased the severity of severe blotchy ripening. This indicates a possible connexion between the virus and potash metabolism within the host plant. It focuses attention upon the need for careful control of potash manuring, particularly with the variety 'Potentate', on which the experiments were performed.

Mineral Resources of Eire

EMERGENCY PERIOD PAMPHLET No. 1 of the Geological Survey of Ireland (Stationery Office, Dublin) is a short review by D. W. Bishopp of Irish mineral resources and the possibilities of developing them. It is suggested that a limited quantity of coal will be obtainable for some time to come, though only with difficulty and expense, and that any rapid expansion of output to compensate for more than a fraction of the normal imports (now cut off) would be impracticable. In the case of metalliferous minerals, the mineral belt of Avoca still holds out some hope of further profitable exploitation. On the whole, however, the prospects of reviving an industry in copper are unfavourable, and the lead-zinc-silver deposits are also far from encouraging, though it is not overlooked that entirely new deposits or extensions of known ones may exist beneath the blankets of bog and glacial drift which hide vast areas of the underlying bedrocks. Of the non-metallic minerals which are at present being worked (structural materials ; rock phosphate in the Carboniferous beds of West Clare; gypsum in the Trias of Carrickmacross and Kingscourt; barytes in Co. Sligo; pyrites, for sulphur, in Avoca; and quartz from Muckish) there is no likelihood of a shortage in the near future.

Potassium *para*-Phenolsulphonate as a Buffer

THE pH range of 8·6–9·0, between those for borates and secondary phosphates, is usefully filled by potassium *para*-phenolsulphonate. The purified product is not commercially available, but E. E. Sager, M. R. Schooley and S. F. Acree (*J. Res. U.S. Nat. Bureau of Stand.*, **31**, 197; 1943) find that the manufactured material may be decolorized by treating a hot solution with activated carbon and recrystallizing three times. A quantitative method of analysis by bromine titration is described. Ultraviolet absorption spectra showed differences between the primary and secondary salt, and indicated that the sulphonate group is almost completely ionized in dilute solution. Now that detailed information is available, it seems likely that potassium *para*-phenolsulphonate should find useful application as a buffer substance. In the same journal (**31**, 205; 1943), R. G. Bates, G. L. Siegel and S. F. Acree describe measurements of the thermodynamic second dissociation constant K_2 of *para*-phenol sulphonic acid by means of electromotive forces of hydrogen–silver chloride cells without liquid junction, using buffer mixtures of the potassium salt, sodium hydroxide and sodium chloride. The results between 0° and 60° C. are given by $pK_2 = 1961{\cdot}2/T - 1{\cdot}1436 + 0{\cdot}012139T$ (T = abs. temp.). The pH values of buffers having the molal ratios m_1/m_2 of phenolsulphonate and bivalent phenolate sulphonate ion between 2/3 and 1 are given by $pH = pK_2 - \log (m_1/m_2) - 3A\sqrt{\mu}/(1 + 8B\sqrt{\mu})$, where μ is the ionic strength and A and B are constants.

Non-linear Optics and Electrodynamics

FOR the past two years the Dublin Institute for Advanced Studies has been engaged on a series of investigations of the consequences of replacing Maxwell's electromagnetic equations by those of Born and Infeld, which are non-linear. The first paper, entitled "Non-linear Optics", by Prof. E. Schrödinger (*Proc. Roy. Irish Acad.*, **47**, 77; 1942), dealt, among other matters, with the mutual influence of light waves. It showed that light is refracted by light, and that two light rays experience mutual scattering. Further developments were given in later papers (*ibid.*, **48A**, 91; 1942; and **49A**, 4; 1943). The extension to non-linear quantum electrodynamics was undertaken by J. McConnell (*ibid.*, **49A**, 149; 1943), and showed the great complexity of the problem. The results agree closely with those already obtained in Schrödinger's papers, but there are grave difficulties to overcome, which, it is suggested, may be resolved by using the theory of radiation damping due to W. Heitler and H. W. Peng (*Proc. Camb. Phil. Soc.*, **37**, 291; 1941; and **38**, 296; 1942). The final conclusion is that we arrive at a reasonable theoretical picture of a process, which has never actually been observed, but is certainly small enough not to be in contradiction with the present negative experimental evidence.

Solar Flares and Magnetic Storms

H. W. NEWTON, in a paper with this title (*Mon. Not. Roy. Astro. Soc.*, **103**, 5; 1943), deals chiefly with magnetic storms that follow intense flares after several hours. A large amount of observational data has been collected between 1859 and 1942, and details of the time, duration and position on the disk of thirty-seven intense flares are listed. In twenty-seven cases magnetic storms began within two days of the flares, and the percentage association is higher for the central zone of the disk (0°–45°). The occurrence of the smaller storms, which show a recurrence tendency, is explicable on the theory of a corpuscular stream emitted more or less continuously for weeks, partaking of the sun's rotation, and overtaking the earth in its orbit at intervals of 27 days. This view cannot be reconciled with the occurrence of the great magnetic storms, which show no pronounced tendency to recur at intervals of 27 days, and the following features are suggested as operating in the latter case. A newly formed corpuscular stream is ejected at the time and place of the great flare, and when this stream reaches the earth's orbit in a period of about 20–26 hours, the five greatest storms giving the former period, the earth itself is included in a 'head-on' encounter. The stream of corpuscles has a wide front, the semi-angle of the equivalent cone being often as large as 40°, and sometimes greater. Although it is concluded that for every *great* magnetic storm there is a high probability that it has been preceded about twenty-four hours earlier by an intense solar flare, the smaller storms still present a problem. They continue throughout solar minimum, when great sunspots, flares and great magnetic storms have temporarily ceased (see also NATURE, April 15, p. 452).

X-RAY ANALYSIS IN INDUSTRY

CONFERENCE OF THE X-RAY ANALYSIS GROUP OF THE INSTITUTE OF PHYSICS

THE third Institute of Physics Conference on X-ray analysis in industry was held in Oxford on March 31 and April 1. This year it was organized by the newly formed X-ray Analysis Group of the Institute and followed the first annual general meeting. Attendance was not, however, confined to members of the Group; indeed, non-members were in the majority among the two hundred present.

The chairman of the Group, Sir Lawrence Bragg, presided. In opening the conference he pointed out that the title "X-Rays in Industry" does not mean that academic work is excluded; one of the main objects of the Group is to link more closely the work of the universities and of industry. This point was well illustrated by the papers read at the first session. The subject—the analysis of complex organic compounds—may have appeared highly academic, yet in the discussion it was obvious that it is of great interest to, for example, the rubber and plastics industries.

Complex Organic Compounds

In the first paper, Dr. E. G. Cox pointed out that there is no royal road to success in solving crystal structures; there is still a great deal of trial and error work, and the computations involved may be quite extensive. He emphasized that, for a complicated structure, a large number of approximate intensities is better than a few accurate ones. Moreover, it is almost a necessity to use three-dimensional methods except when a flat molecule is being studied. This is due to the low resolving power, which is only about 0·5 A.; the projections of atoms on a plane often fall closer than this, but in three dimensions they cannot be closer than 1A. Accuracy should not be sought for its own sake, but where accuracy is required, crystallographers should state precisely what they have achieved. It is necessary, above all, that their results should be dependable.

Dr. Dorothy Crowfoot gave an account of the work upon which she had been engaged with Dr. C. H. Carlisle, on the structure of cholesteryl iodide. She led up to this by a brief summary of the work of Bernal on the sterols, and pointed out the difficulties that often attend the investigation of such crystal structures. These difficulties can sometimes be overcome if the structure contains a heavy atom, since this will largely determine the relative phases of the structure amplitudes. Cholesteryl iodide gave an opportunity of trying out these ideas in the general case, for it has no centre of symmetry. In spite of this, it was found possible to derive the complete structure of one of the forms.

Two-dimensional Fourier synthesis was used and was supplemented by the information given by line synthesis through the peaks in the projection. There was, however, an inherent difficulty in that the method gave the correct structure overlaid with its mirror-image, and in order to sort out the true structure, knowledge of interatomic distances had to be used. Apart from the operation of finding which peaks represented related atoms, the determination of the structure was entirely direct.

Mr. H. M. Powell described some recent work he had done in collaboration with Dr. Huse and Mr. Cooke. This had as its aim the discovery of the nature of the intermolecular forces in aromatic compounds. A large range of compounds was first reviewed to see which were likely to be solvable. In agreement with Dr. Crowfoot, he stressed the value of a heavy atom in the structure; but he showed that this can have its limitations also. For a molecule containing three iodine atoms the detail of the carbon atoms was completely 'swamped'; with only one iodine atom, however (*para*-iodoaniline-*sym*-trinitrobenzene), it had been found possible to work out the complete structure by successive refinement of two-dimensional Fourier synthesis. The result arrived at was that the forces binding the molecules are certainly not covalent, but are probably of the van der Waals type, although some of the interatomic distances are rather short. Mr. Powell concluded by showing X-ray photographs containing 'smear' lines, and gave a possible explanation based on 'mistakes' in the packing of the molecules.

In the discussion, Dr. C. A. Beevers expressed the opinion that three-dimensional Patterson synthesis should be applied to structures that will not succumb to the methods so far described. The method is to calculate sections at special values of the parameters. Dr. Smare agreed with the possibilities envisaged, but said that in carotene, $C_{40}H_{56}$, it is surprising how many chance peaks occur in such planes. Dr. Cox explained this by the lack of resolution.

Dr. K. Lonsdale pointed out the need for correcting for extinction before improving methods of measurement of intensities. She showed some 'divergent-beam' photographs of certain organic crystals. These were very poor, but after the crystals had been dipped in liquid air, greatly improved photographs were obtained. The poor quality of the original photographs was due to the presence of extinction; dipping into liquid air decreased the perfection of the crystals and so decreased the extinction. Dr. H. Lipson also questioned the accuracy claimed by some workers; he gave theoretical reasons for thinking that an accuracy of 0·02 A. could not be reached with Fourier synthesis. Dr. G. A. Jeffrey, on the other hand, instanced the remarkable consistency of bond-lengths derived from different crystals.

Mr. C. W. Bunn thought that trial and error methods still have a place in the determination of structures, and that they have been given a new lease of life by the optical method devised by Sir Lawrence Bragg. Essentially this method reproduces with ordinary light the diffraction of X-rays by a crystal, and a complete zone of intensities can be determined in about an hour even for a complicated structure.

Dr. I. MacArthur urged the use of the variation of physical conditions, particularly temperature. He showed a set of X-ray photographs that have in this way produced valuable evidence of the structure of the ketones.

Finally, Prof. N. V. Sidgwick questioned the generality of Mr. Powell's conclusion that the forces between aromatic molecules are of the van der Waals type; it might be true for one compound, but not for others.

Fibres

The first session on the second day was devoted to fibres and other types of imperfect structure. Dr. W. T. Astbury showed diffraction photographs of a number of fibres, including 'powder-like' fibres

giving very diffuse rings, stretched poly-*iso*butylene, which gives sharp spots, and keratin fibres which give intermolecular patterns. He also showed photographs of such protein fibres as porcupine quill, which give many orders of diffraction, showing evidence of a spacing of more than 600 A. in the structure. The former fibres give much sharper photographs when stretched, while the latter do not.

The physical properties of a fibre are changed considerably when the fibre is wetted, but its diffraction spectra remain the same. Different fibres with very different strengths can give photographs indistinguishable from each other. Thus X-rays do not yet give complete information about the technical properties of fibres, since the X-ray spectra are due to the crystallinity of the fibre, while the mechanical properties depend mainly on the less organized (amorphous) parts, which only affect the background of the photograph.

Dr. E. Aruja described some work on the structure of chrysotile, one of the asbestos minerals. He showed an X-ray photograph in which some of the spots are drawn out into streaks along the layer lines, owing to imperfection in the structure. Chrysotile is formed of hexagonal sheets of SiO_4 units alternating with brucite layers, and since these layers have slightly different cell dimensions the sheets may be expected to be curved. This accounts both for 'mistakes' in the structure and for the fibrousness of chrysotile. The photometer curves of the streaks have been correlated with Warren's calculations on the intensity of diffraction from imperfect layer structures. Antigorite, a substance having the same chemical composition as chrysotile, differs in having a lamellar structure.

Mr. C. W. Bunn spoke on the structure of high polymers. Although one cannot obtain single crystals of these, they can be partially oriented by stretching or rolling, and the amount of X-ray evidence available is generally adequate for structure determination. There is generally 5–10 per cent of disordered material in polymer specimens. The usual methods of structure determination are employed, except that little use can be made of Fourier methods. The intensities calculated from trial structures based on stereochemical knowledge are compared with observed intensities, the values of which can be estimated visually with sufficient accuracy. For this purpose all available spectra must be employed. When the most probable structure has been found, there may still be some disagreement between calculated and observed intensities; this may often be attributed to anisotropic thermal vibrations, rotation of chains about their axis, and the distortion of electron clouds in $=CH_2$ groups. This last effect has been observed in polyethylene, and confirmed by evidence from 'thermal' spots.

Prof. H. L. Riley gave a summary of the theory of the formation of coals, and described work done with the object of elucidating coal structure. Chars produced at various temperatures from a number of organic compounds show a remarkable constancy of particle thickness of about 10 A., as indicated by the breadth of the 0002 reflexion. This is not so with coals, which give particle sizes varying with the charring temperature, the variation being of a different form for different coals. Part of this variation may be attributed to the packing of flat units under the influence of thermal agitation, but this packing would appear to reach a limit at 550° C. For the cause of subsequent changes we must look to the effect of heat on other components of coal. It is therefore interesting to observe that particle sizes of dibenzanthrone chars show much the same variation with charring temperature as those of coking coals.

In the discussion which followed, Dr. D. P. Riley spoke of the study by X-rays of 'amorphous' materials, like carbon black, and said that diffraction photographs show three parts, interatomic, intermolecular and interparticle, the last-named occurring at the lowest scattering angles, and giving useful information about the particle sizes. Dr. G. Coumoulos described some plastics which always appear 'amorphous', in spite of stretching, owing to the presence of long side-chains in their structures. Dr. A. R. Stokes suggested that information about the form of 'mistakes' in a structure can be gained by using the fact that the only fuzzy reflexions are those for which the structure amplitude is changed by the mistake; the other reflexions are sharp.

Preferred Orientation in Wires and Sheets

The subject discussed in the final session was preferred orientation in wires and sheets. Dr. W. H. Taylor opened with a short account of the stereographic projection, which forms the basis of the pole-figure method of representing preferred orientation. He pointed out that, while the projection of a single crystal represents many planes, the pole figure of a polycrystalline material represents only one set; thus a series of pole-figures will in general be required for the same specimen.

Preferred orientation sets in after a material has been broken up into a mosaic structure by cold-work, that is, after the point at which fracture would have taken place in a straight tensile test. The mechanism of re-orientation involves both slip and twinning; but the latter has, as yet, received much less attention than the former.

Dr. Taylor then described some work on magnesium sheet containing 2 per cent of manganese. Transmission X-ray photographs were first taken; but the disadvantage was that only the average orientation over the whole thickness was studied. A better method was to take surface reflexion photographs and to examine the orientation at different levels by successive etchings of the surface. It was found that the basal plane (0002) of the hexagonal structure was brought approximately into the plane of the sheet. Below the surface a double orientation sets in, the basal plane tending to set at $\pm 15°$ to the plane of the sheet along the rolling direction. A complete description of the orientation is still lacking.

Mr. H. P. Rooksby described some results of the examination of tungsten and molybdenum wires and sheets. The drawn wire shows a texture characteristic of the body-centred cubic metals, [110]* tending to lie along the wire axis; this orientation is more closely approached the greater the reduction in diameter. Etching away the surface shows that the orientation becomes more nearly complete in the centre.

The rolling process restricts the orientation still further, since there is a tendency both for (100) to become parallel to the surface of the sheet, and for [110] to become parallel to the rolling direction. X-ray photographs show, however, that there is a

* Indices enclosed in round brackets represent planes; those enclosed in square brackets represent zone axes or directions in the crystal.

considerable deviation about the rolling direction. Successive rolling in two perpendicular directions reduces this deviation so much that the resulting sheet has almost the properties of a single crystal; in particular, it has a pronounced cleavage at 45° to the rolling directions, and this is very objectionable in practice. For this reason the successive rollings at right angles must be replaced by a uni-directional rolling.

Dr. J. T. Randall dealt with orientation properties of sheet steel for electrical machinery and transformers. Up to 4½ per cent of silicon is added to the iron from which these sheets are made in order to reduce the oxygen content and to increase the resistivity. The impurities left, however, still have a great influence on the magnetic and orientation properties of the material, which differ greatly from those of pure iron. The crystals in hot-rolled silicon-iron sheet are oriented with [110] parallel to the direction of rolling and (100) in the plane of the sheet, whereas cold-rolled (Goss) sheet has [100] and (110) in these orientations. The Goss sheet is therefore preferable for transformers, since [100] is the direction of easy magnetization and should therefore lie in the direction of the flux.

Dr. Randall emphasized the danger of introducing cold-work into the specimen; for most methods of X-ray examination it is usual to cut small pieces from the sheet, and the proportion of cold-worked to undeformed material is high. This difficulty cannot be overcome by etching, which itself may have some preferential effect. Methods which do not have these defects are the study of etch pits and the torque magnetometer.

In the discussion, Mr. G. C. Richer suggested that there may be disordered regions between the magnetic domains in transformer sheet; these cannot easily be detected by X-ray methods but they may influence the magnetic properties.

Dr. T. Ll. Richards underlined the necessity for using the stereographic projection, and described how he has studied the orientation of chromium plating.

Dr. W. F. Berg showed slides of some back-reflexion Laue spots from transformer sheet, and suggested that the fine structure they possess might give some information about slip planes in the crystals.

Mr. E. E. Spillett emphasized the importance of preferred orientation in aluminium. Nevertheless, there are still some problems left unsolved; for example, there does not appear to be any simple correlation between the hardness and the degree of preferred orientation in an annealed sample which was examined by X-rays. The orientation in aluminium tube is dependent on whether a reduction of diameter or of wall thickness predominates. In the former case, [111] is parallel to the tube axis as in drawn wire, and in the latter [112] is parallel to the axis as in rolled sheet.

Dr. A. Hargreaves described a moving film method of recording glancing-angle reflexions for a rotating sheet specimen; in this way the information necessary to draw almost a complete pole-figure for one set of planes can be obtained from one photograph, and Dr. Hargreaves has used it to show the double orientation in magnesium sheet.

In the evening of the first day of the conference, Dr. P. P. Ewald gave an entertaining account of the international development of crystallography. Being in the subject at its beginning, he was able to give personal recollections of most of the great men of the subject. He described the various meetings which have been held since the War of 1914–18 to discuss rational organization, and showed the undoubted influence that these meetings have had. He then discussed the progress of the subject in terms of the titles of books published, and concluded by a well-thought-out plan for the future.

REFORM OF SCHOOL MATHEMATICAL SYLLABUSES

A GENERAL meeting of the Mathematical Association, the first to be held since the outbreak of the War, took place at King's College, London, on April 12 and 13. The meeting attracted a large number of members; the president, Mr. W. C. Fletcher, took the chair during the first part of the meeting and Prof. E. H. Neville deputized for him later.

The afternoon session on April 12 was devoted to a discussion on possible changes in the mathematical syllabus for the various School Certificate examinations. The discussion was opened by Mr. C. T. Daltry, who outlined some preliminary work done by the Association in 1938 and went on to consider the alternative geometry syllabus recently introduced by the Cambridge Local Examinations Syndicate. The principal points in this syllabus are: (*a*) a reduction in the number of theorems to be proved; (*b*) a more definite fusing of geometry and trigonometry; (*c*) the introduction of more practical material from map reading, plan- and elevation-drawing, etc. Mr. Daltry advocated a similar type of reform in regard to algebra, where the reduction of formal manipulative work would leave time for more progress in graphs and functionality, and the possible introduction of the easiest parts of the calculus (as an optional subject). He further recommended the general adoption of the 'mixed-subject' type of examination paper, each paper to be divided into an easy section where accuracy might be the principal requisite, followed by a section in which a choice of questions should be given.

Dr. F. C. Powell gave an account of the circumstances leading to the introduction of the Cambridge alternative syllabus. After contrasting the mathematical and physical approaches to any subject, he stated that in this syllabus a physical approach to the teaching of geometry is contemplated. This has led to the retention of only those parts of geometry which are useful in developing applications and have a definite practical value, and to the rejection of parts of the work which, though interesting in themselves, have no bearing on such development. It is too early, he said, to make an exact assessment of the degree of popularity which the new syllabus will achieve, but the response so far has made it clear that teachers are very ready to welcome such changes.

An interesting discussion followed, in the course of which general agreement was expressed in regard to most of the points raised, though doubt was expressed by some members as to the advisability of introducing calculus at too early a stage.

At the conclusion of the discussion, four resolutions were proposed by Mr. G. L. Parsons. The first two of these, which were passed unanimously, were as follows:

(i) "This meeting of the Mathematical Association is in favour of a general revision of the syllabus in Mathematics demanded of candidates for the School Certificate examination."

(ii) "This meeting is in favour of a reduction in the number of theorems of which candidates are expected to produce a formal proof and approves of the general principle that the work in Geometry and Trigonometry should be more closely co-ordinated. A more extensive use of three-dimensional ideas and a more practical approach are also desirable."

The third resolution, which found only a few dissentients, was as follows: "This meeting considers that a reduction should be made in the amount of formal Algebra demanded and that the time thus saved should be given to the study of graphs and functionality."

A last resolution, passed by a substantial majority, read: "This meeting would approve the introduction of elementary Calculus, treated principally from a graphical angle, as an *optional* element in Elementary Mathematics papers".

The remainder of the proceedings on the first day were devoted to papers by Mr. W. W. Sawyer on "The Theory of Functions" and Prof. L. M. Milne-Thomson on "Harmonic Analysis".

The meeting re-opened on Thursday with a demonstration by Mr. C. W. Hansel of the use of an apparatus consisting of a large mirror mounted at 45° to the horizontal in the teaching of mathematics. This apparatus allows a class to get a clear view of diagrams and other objects placed in a horizontal plane. A paper on "Infinite Series for Fifth Formers", given by Mr. N. M. Gibbins, concluded the morning session.

The main discussion in the afternoon dealt with a new Higher Certificate mathematical syllabus, drawn up by the Science Masters Association assisted by a number of members of the Mathematical Association. The discussion was opened by Mr. E. H. Lockwood, who gave an account of the events which led to these proposals. He outlined the various levels aimed at in the syllabus, and explained how this syllabus could, by a certain amount of adjustment, be made to fit in with the syllabus required by potential mathematical scholars. In the minimum syllabus, which was planned for a five-term course, emphasis has been placed on calculus and the function idea at the expense of geometry; and elementary rotational dynamics at the expense of more elaborate statics. In the advanced section of the syllabus, the same ideas have been followed out, for example, by the preference of differential equations, determinants, vectors and complex numbers to the usual work on the geometry of conics.

Mr. A. E. E. Mackenzie continued the discussion on behalf of the Science Masters Association, giving some account of the general background and of parallel activities which are being pursued in relation to other branches of science. He referred to widespread criticism from various quarters of the level reached by science students. He considers that the fundamental cause of this criticism is the overloading of the syllabus. An important step in redressing this state of affairs has recently been made in the setting up of advisory committees containing representatives of the teaching associations and some of the examining bodies. These committees, including one dealing with mathematics, have recently approved various proposals with regard to the scholarship syllabuses, and it is hoped that a general co-ordination of the Higher Certificate syllabuses and the scholarship syllabuses will become an established fact.

Dr. F. C. Powell referred to the genuine feeling existing among university teachers that the time has come to make changes in co-operation with the schools. The new advisory committees would certainly prove valuable in this work. He proceeded to an analysis of some of the points where difficulty has been experienced in practice in making a 'clean joint' between school and university work, and welcomed the appearance of differential equations and other parts of the proposed syllabus which would help to eliminate these difficulties.

Mr. C. G. Nobbs reviewed the proposed syllabus in considerable detail and answered certain points raised by previous speakers. He showed how the syllabus has been developed logically from the idea of functionality, and how various parts of the usually accepted mathematical course have been omitted, not because they are not interesting or even useful, but because they do not fit in with this central idea. He referred to the omission of geometry as being occasioned principally by considerations of time. He hoped the syllabus would not prove too long and that members would give it a trial.

A large number of members took part in the subsequent discussion, which in the main favoured the new proposals, especially in the 'ordinary' part of the syllabus. A number of speakers referred to the question of undue length, especially for girls. The view was expressed that the advanced syllabus might be abbreviated by a reasonable system of alternatives.

The final paper of the meeting was given by Mr. W. Hope Jones, in his usual entertaining style, the subject being "More Mathematical Geography".

At the business meeting of the Association, Mr. C. O. Tuckey was elected president for 1944 and the other officers were re-elected. The Council's report showed that the Association has well maintained its membership and is in a sound financial condition. Reference was made to the excellent work of Prof. T. A. A. Broadbent in maintaining the standard of the *Mathematical Gazette* in spite of paper restrictions and other war-time difficulties. A full report of the proceedings will be given, as space permits, in that journal.

CONTROL OF TYPHUS

RECENT references in the daily Press to the appearance of typhus in eastern Europe have prompted a number of questions. What risk is there of outbreaks of typhus among British troops abroad, or of its introduction into Great Britain? What risks will there be of outbreaks of typhus in Europe after the War? Articles in the medical Press show that the whole problem of typhus is being considered all over the world; for typhus is always a serious matter, whether nations are at war or at peace.

At the present time, of course, British troops are contending with an outbreak of typhus in Naples, which has (*Brit. Med. J.*, Feb. 5, 1944, p. 205) become so serious that it is a potential menace to military operations. So far it is confined to civilians. Immunization by serum has been organized, and some 70,000 civilians a day are being treated for infestation with lice. The outbreak began under German occupation, and has increased since the German destruction of the gas and water supplies, and as a result of

overcrowding with refugees and others. It is evidently being vigorously attacked.

Some of the risks run by British troops in the Middle East are indicated by abstracts in the *Bulletin of War Medicine* and by an article by two R.A.M.C. officers, Lieut.-Colonel W. Brockbank and Major S. R. F. Whittaker (*The Lancet*, Jan. 29, p. 150). According to these authors, although the incidence of typhus is high among civilians in some parts of the Middle East, only sporadic cases have occurred so far among troops there. They describe ten cases, all of whom were British soldiers, which they treated between March and May, 1943. They direct attention to the fact that the early symptoms of typhus may be so like those of malaria, sand-fly fever, relapsing fever or typhoid that a diagnosis when the patient reports sick may be very difficult. The patient may stay for some days in a general ward in a hospital before the diagnosis can be made. Actually eight out of the ten cases described remained in a general ward until the rash of typhus fever appeared on the fifth or sixth day of the illness. The diagnosis was made more difficult by the fact that evidence of the presence of, or contact with, lice was present in only one of the ten cases. Fortunately, no cross-infection occurred. The mortality-rate from typhus is higher in patients more than thirty years old, so that the authors recommend that no personnel older than this should be detailed for duties likely to expose them to contact with typhus. Further, all personnel likely to come into contact with typhus are now given typhus vaccine. The efficacy of the typhus vaccines has been questioned, but Dr. J. B. Penfold, of the Emergency Pathological Service Laboratory, Billericay, reports (*Brit. Med. J.*, Jan. 22, 1944, p. 114) on tests made with a Cox vaccine prepared in Toronto from a European louse-borne strain of *Rickettsia prowazeki*. He vaccinated 23 public health workers with this, and found that the reactions to it were generally slight and local, and that vaccination produced an increase of the agglutination titres in most cases. Drs. Bardhan, Tyagi and Boutros, of No. 12 Field Laboratory, M.E.F., have reported (*Brit. Med. J.*, Feb. 19, 1944, p. 253) on the glass-slide agglutination test for the rapid diagnosis of typhus, modified by them for general use. They urge further trials of this method to establish conclusively the degree of its reliability.

Typhus risks in Europe are discussed by Dr. Yves Biraud, of the Epidemiological Service at Geneva (*Bull. Health Org. League of Nations*, **10**, No. 1; 1943. See *The Lancet*, May 15, 1943, p. 620, and the fuller abstract in the *Bulletin of War Medicine*, **3**, No. 10, 567; 1943). Dr. Biraud says that typhus has increased in Poland and the Balkans to a disquieting, but not to an alarming, degree since the outbreak of the War. Sporadic foci have also appeared in Germany and Hungary in areas which have been free from the disease; presumably these have been brought from the Eastern front. We may compare this with the outbreaks in German troops of another disease not prevalent in Germany before the War, namely, trichiniasis, which has occurred in Norway and on the Eastern front. Sporadic foci of typhus have also been found in central and southern France; but almost all the cases in these areas have been people arriving from North Africa, where the disease is always present. Bad economic conditions, such as those which resulted from the fall of France, increased its incidence in North Africa. It is not surprising that the incidence in 1941 was more than twice that recorded for any of the preceding twenty years, and that the 1941 figures were exceeded in the early months of 1942.

Typhus in Iran was the subject of an address by Col. Faruqi, I.M.S., to the recently formed Anglo-Iranian Medical Society (*Brit. Med. J.*, Dec. 25, 1943, p. 820). Last year, said Col. Faruqi, typhus killed many people and he feared a much more serious epidemic. He explained that there are plenty of medical men with wide experience of typhus now in Iran, but suggested the formation of a committee to control preventive work and to co-ordinate information.

In Spain the typhus epidemic of 1908–9 stimulated intensive study of the treatment and prevention of the disease. An account of the modern methods now being used in Madrid is given by Prof. Clavero del Campo, director of the National Institute of Health, and Dr. Perez Gallardo in a monograph entitled "Técnicas de Laboratorio en el Tifus Exantemático". This is an official publication of the Dirección General de Sanidad, Madrid, and was published in 1943. To it the director-general of health, Prof. J. A. Palanca, contributes an introduction which outlines the measures taken against these two epidemics and indicates the areas invaded by the disease. After the epidemic of 1908–9, he says, sporadic cases occurred in Spain until the epidemic of 1941–42 began. While it is as yet too early, he thinks, to claim that the latter epidemic has been conquered, it has been controlled. His account of the difficulties encountered and the measures taken shows that full advantage is being taken of the experience of specialists in other countries and of the experience gained by Dr. Gallardo when he was sent to laboratories in Germany, Poland and elsewhere. Such difficulties as the destruction by war of the National Institute of Health and the modern Rockefeller Virus Department might have daunted any but the most persistent and enthusiastic workers.

In another paper Prof. Clavero and Dr. Gallardo give the results of their work on a strain of *R. prowazeki* originally isolated and cultivated by the Cox technique on chick embryos by Dr. Snyder in 1941, and on a variant of this strain which has lost its pathogenicity, yet has retained its immunizing power (*Revista de Sanidad e Higiene Publica*, Madrid, June 1943). In further papers they report on their work on Giroud's intradermal test for typhus infection (*ibid.*, Dec. 1942) and on their investigation (*ibid.*, May 1943) of 384 rats and 62 fleas in Madrid, from which they conclude that a murine virus does not exist in the rats of Madrid. They discuss the errors which may arise from the presence in rats of various bacterial infections (*Salmonella enteritidis*, *B. alcaligenes broncho-septicus*, Spirochætes, etc.). We have already referred to the work of other Spanish medical men on typhus in some of the Latin-American countries: in Venezuela, for example (NATURE, Jan. 8, 1944, p. 51), and Bolivia (NATURE, Feb. 5, 1944, p. 162). The existence of endemic typhus in Bogotá, Colombia, is reported by Prof. Luis Patiño-Carmago (*Rev. de la Facultad de Medicina, Bogotá*, **11**, 503; 1943), who claims that eight strains of the Rickettsia type have been found in various parts of Colombia. The pages of this journal and of the *Boletin de la Oficina Sanitaria Panamericana* show that typhus is being carefully watched and combated throughout Latin and North America.

Finally, reference may be made to an annotation in *The Lancet* (May 1, 1943, p. 562) which discusses the precautions taken against the entry of typhus

into the British Isles. Control depends on the control of the head or body louse infected with *R. prowazeki*, on prompt isolation of patients and contacts, delousing, disinfection of both the premises of the patients and the contacts, and on other measures which can only be carried out effectively by specially trained personnel. These personnel must be themselves protected (by protective clothing, vaccination, etc.). In England such mobile anti-typhus squads were formed some time ago. The shortage of nursing personnel made it difficult to provide suitable people for this duty, because they must be young (see above); but plenty of volunteers were available. At the same time, many authorities earmarked suitable sections of isolation hospitals for possible typhus cases. Such measures as these, combined with the strict watch which is kept at ports of entry and on aeroplanes, indicate that the risk of the entry of typhus into the British Isles is not being neglected. G. LAPAGE.

FORTHCOMING EVENTS

Friday, April 28—Sunday, April 30

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at the Waldorf Hotel, Aldwych, London, W.C.2). Conference on "Management and Society".

Saturday, April 29

BRITISH RHEOLOGISTS' CLUB (at the Shirley Institute, Didsbury, Manchester), at 10 a.m.—Discussion on "Elastic Behaviour of Textile Materials".

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—"Photography as a Tool in Agriculture" (Papers will be read by Dr. E. N. Crook and Mr. V. Stansfield, and by a Representative of the National Institute of Agricultural Engineering).

PHYSICAL SOCIETY (at the new Clarendon Laboratory, Oxford), at 2.30 p.m.—Prof. Joel H. Hildebrand: "The Liquid State" (Twenty-eighth Guthrie Lecture).

Monday, May 1

SOCIETY OF ENGINEERS (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Mr. R. H. Bound: "Aircraft Hydraulic Equipment".

INSTITUTION OF ELECTRICAL ENGINEERS (CAMBRIDGE AND DISTRICT WIRELESS GROUP) (at the Technical School, Cambridge), at 5.30 p.m.—Mr. C. R. Stoner and Mr. R. W. Wilson: Discussion on "Training for the Radio Industry".

Tuesday, May 2

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield 1), at 6.30 p.m.—Mr J. S. Ridges: "The Work of the Iron and Steel Control".

Wednesday, May 3

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.15 p.m.—Silver Jubilee Commemoration Meeting.

Thursday, May 4

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. L. G. Grimmett: "The Electrostatic Generator, its Development and Prospects".

INSTITUTION OF ELECTRICAL ENGINEERS (INSTALLATIONS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. W. N. C. Finch and Mr. F. Lynn: "The Design and Performance of Domestic Electric Appliances".

Friday, May 5

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. S. Kennard: "The Crayford Brickearths".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN THE MECHANICAL AND CIVIL ENGINEERING DEPARTMENT—The Registrar, Technical College, Sunderland (May 5).

SECRETARY (temporary) of the Department of Agriculture—The Acting Registrar, The University, Leeds 2 (May 6).

Permanent BIOLOGIST (male or female) in the Public Health Department—The Medical Officer of Health, Town Hall, Luton (May 8).

EDUCATIONAL PSYCHOLOGIST (full-time), and a PSYCHIATRIC SOCIAL WORKER (full-time)—The Director and Secretary, Education Offices, Brettenham Road, Edmonton, London, N.18 (May 8).

TECHNICAL OFFICER to advise on questions of cropping and manuring of arable land and the management of dairy stock—The Secretary, Berkshire War Agricultural Executive Committee, 1 Abbot's Walk, Reading (May 8).

LECTURER (full-time) IN ELECTRICAL ENGINEERING at the Lancaster Technical College—The Director of Education, High Street House, Lancaster (May 8).

PRINCIPAL OF THE BLACKPOOL AND FYLDE TECHNICAL COLLEGE—The Director of Education, 3 Caunce Street, Blackpool (May 8).

DRUMMOND PROFESSORSHIP OF POLITICAL ECONOMY—The Registrar, University Registry, Oxford (May 13).

UNIVERSITY READERSHIP IN CHEMICAL PATHOLOGY tenable at University College Hospital Medical School—The Academic Registrar, University of London, at Richmond College, Richmond, Surrey (May 15).

LECTURER IN SCIENCE AND ELEMENTARY ENGINEERING SUBJECTS—The Principal, County Technical College, Worksop, Notts. (May 15).

ENGINEERING INSPECTOR OF MINES (temporary) in a Government Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2088A) (May 17).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

CHIEF ENGINEER AND GENERAL MANAGER of the Gloucester Electricity Undertaking—The Town Clerk, Guildhall, Gloucester.

GRADUATE LECTURER IN ELECTRICAL ENGINEERING at the Southend-on-Sea Municipal College—The Chief Education Officer, Education Office, Warrior Square, Southend-on-Sea.

LECTURER (full-time) IN MATHEMATICS—The Registrar, Municipal College, Portsmouth.

LECTURER (temporary) in MECHANICAL ENGINEERING—The Principal, Handsworth Technical College, Golds Hill Road, Handsworth, Birmingham 21.

PHYSICIST to the Newcastle-upon-Tyne National Radium Centre—Dr. A. W. Sanderson, Secretary of Newcastle-upon-Tyne National Radium Centre, Royal Victoria Infirmary, Newcastle-upon-Tyne.

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(not included in the monthly Books Supplement)

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SCIENTIFIC RESEARCH IN GREAT BRITAIN

SCIENTIFIC workers have every reason to regard the debate in the House of Commons on April 19 on Sir Granville Gibson's motion calling for a bold and generous Government policy towards research with as much satisfaction as Mr. Attlee's encouraging reply. The debate itself ranged over a wide ground, and no scientific worker could desire to have so many of his points made more effectively or trenchantly than was done in its course. The case for adequate remuneration of the scientific worker was pressed even more forcibly than in the House of Lords debate last July, and the arguments on this point of Sir Granville himself, Mr. E. W. Salt, Mr. Edmund Harvey, Mr. J. Griffiths, Mr. Owen Evans and Captain Plugge, who touched also on the broad question of incentives, would have seemed incredible in a Parliamentary debate ten or twenty years ago.

The credit for this change of outlook must be attributed in no small measure to the work of the Parliamentary and Scientific Committee, the reports of which have done much to prepare the ground for the debate. It should be noted, however, that other recent reports dealing with scientific and industrial research, notably that from the London Chamber of Commerce, have tended to stress the importance of adequate remuneration if we are to attract men of outstanding ability to a career of scientific or industrial research, and the direction of such research. The note was equally prominent in the series of addresses on "Science and Industry" recently arranged by the Manchester Chamber of Commerce, and after Mr. D. Owen Evans's emphatic comment on the comparative salaries offered for research directors in the Government service, Mr. Attlee gave the assurance that the whole question of the payment of scientific men in Government service in relation to other Government employment of similar status is under consideration, and that already steps have been taken to raise the remuneration of the heads of research institutions.

The point is worth noting, less for its intrinsic importance or prominence in the debate, than as showing the measure of the progress made in recent discussions. The disposition to accord due status to the scientific worker is a factor the importance of which in recruitment and expansion of the ranks of research workers is not easily overstressed. Incidentally, it bears on the organization of the two-way traffic and constant interchange of workers to which Sir George Schuster and also Air-Commodore Helmore both referred in the debate. There are, as Sir George indicated, difficulties in arranging such interchange between research workers in the universities and in industry; but whether or not a special inquiry, as suggested by Sir George, by a committee of university workers and industrialists is required, the establishment both in industry and in the universities of attractive, equable and comparable conditions of remuneration, status and service would remove one formidable obstacle to interchange.

That the importance of status and conditions of service of the research worker should receive recognition in this manner is the more encouraging because the whole spirit of the debate in the House of Commons showed an appreciation of the prime importance of establishing the conditions which not only attract first-class minds to research but also are conducive to creative work. Any idea that the value of research can be measured by the payment made to the research worker was as flatly squashed by Dr. Haden Guest as the idea that research results can be obtained to order was dispelled by the speeches of half a dozen members. Again, the importance of freedom of research work and of the freedom of the whole life of the universities was very well put by Mr. Edmund Harvey and by Mr. Griffiths, and the references to the operation of patent law were obviously prompted by a like concern to secure conditions in which fundamental research could be developed in complete freedom, and that knowledge made available as a result of public expenditure on industrial research should be used for public and not for private ends.

In the tributes paid to the achievements of research workers in Great Britain during and indeed before the War, and also in the refusal to regard quantity as more important than quality when British research effort is compared on a numerical basis with the research effort of other countries, and notably that of the United States, it was clear that members of the House of Commons realize that these factors of status, remuneration and conditions of work are all-important through their direct bearing on the research worker himself. In the expansion of research, whether in industry or at the universities, the personal factor is rightly put first, for unless the requisite quality is there, no amount of organization will enable us to overcome some of the handicaps under which we are placed in Great Britain, or to make the most of such advantages as we may possess.

This agreement on the prime importance of quality in the research worker himself was accompanied by equally emphatic agreement that, in the main, the fundamental research on which progress ultimately depends must be the task of the universities. For this purpose alone, expansion of the universities to meet the post-war situation is imperative; but it is equally imperative to expand the teaching side so as to provide industry with the increasing number of scientific workers required, and, urgently, to be ready to re-train for careers in science and in research men from the Forces who will be released by demobilization. The extent of this expansion is a matter for discussion, but there is already a large measure of agreement that the present annual grant to the universities of Great Britain should be doubled or trebled at an early date, and that capital expenditure of some £10,000,000 will be required over the first five years following the War, and possibly double that figure in a long-term policy. Mr. Attlee, in his reply, made it quite plain, without committing himself to figures, that the Government recognizes there must be much greater expenditure both on fundamental research and on teaching at the universities.

With this general measure of agreement went a further consensus of opinion that adequate provision has not yet been made for continuing in times of peace the fruitful collaboration between science and industry which has contributed so much to the war effort. That was the central question raised by Sir Granville Gibson in moving his resolution, and the evidence that the present position is not regarded as satisfactory is to be found in the suggestions which came from all parts of the House as to the scope of that effort, the organization or co-ordination of our research effort itself, and finally the means by which the effective utilization of results in production can best be secured.

First, as regards scope. Mr. E. W. Salt, who referred in particular to the report of the Parliamentary and Scientific Committee on coal research, emphasized the opportunities which await intensive scientific research in this field; he was strongly supported by Mr. Owen Evans, who put in a powerful plea that our industrial research should be directed to the industrial processes which exist in Great Britain, to the discovery of new industries, and especially to the utilization of raw materials which exist at home and in the Colonial Empire. In particular, he stressed the inadequacy of our geological surveys both at home and in the Colonies. In this plea he was followed by Mr. James Griffiths, who urged the necessity for central direction from the Government if we are to make the fullest use of existing scientific knowledge on the utilization of coal and build upon it a new integrated industrial structure.

Agricultural research in its broadest aspects found equally strong support. The expansion of our research effort in such fields as animal diseases and nutrition, food and nutrition, soil fertility, and biology, including fisheries, was repeatedly urged, and though the formation of an Economic and Social Research Council to take its place by the side of the Agricultural and Medical Research Councils and with the Department of Scientific and Industrial Research was not specifically mentioned in the debate, this vital group of human studies was clearly present in members' minds, as was shown in Mr. Shepherd's plea for research into distributive costs.

The unevenness of the present front of both scientific and industrial research was thus well brought out in the debate, and it was natural that there should be considered the further question as to the ways and means by which this can best be remedied. For the most part, the question as to the means by which some co-ordination could be effected in the expansion of the universities was that with which members were concerned. Mr. Price expressed the opinion that it would be better to bring the machinery responsible for giving grants to the universities more directly under the office of the Lord President of the Council, who already has the Department of Scientific and Industrial Research under his wing. This was one of the points considered in the report of the London Chamber of Commerce, although the committee responsible reached no decision as to whether or not the suggested central research board should be responsible for allocation of grants to the

universities for research. What Mr. Price had chiefly in mind, however, appears to have been that the right point of view is more likely to be represented if the machinery is handled by the department of the Lord President of the Council than by the Treasury.

Mr. Harvey suggested that it would assist, if not the University Grants Committee, at least the work of the universities, if there were formed an advisory council for the universities, to allow for the interchange of experience, for the development of work in harmony in different parts of Great Britain, the prevention of overlapping and the discussion of arrangements for new chairs for new subjects, so that money will not be squandered by three or four universities trying to start a new chair in a particular subject when one university would be sufficient if the effort could be concentrated. This suggestion was dismissed a little summarily by Mr. Attlee, but those who have advanced the idea of a universities advisory council are at least as aware as Mr. Attlee of the tenacity of the universities in regard to their independence and individuality, and of the practical difficulties of establishing any such body. In this connexion the proposal for the formation of a joint standing council of representatives of the University of Manchester and the Chamber of Commerce might have potentialities for university co-operation as well as for co-operation between science and industry.

To dismiss the suggestion without any constructive proposal as alternative is going too far at the present time. However generously the Government may be disposed—and able—to augment the grants for teaching and research at the universities, the best use cannot be made of the money available unless it is distributed in accordance with some definite plan based on national needs and not those of individual universities or even of regions. Sir Ernest Simon's recent pamphlet affords decisive support on this point for such criticism of duplication and waste as is to be found in "Redbrick University", for example. It should not prove an insuperable task to recast the functions and powers of the University Grants Committee to provide the essential machinery for such co-ordination if the establishment of a new body is inexpedient. Beyond this, there is the question of new universities and of the expansion of the technical colleges to university status—a question which should be considered from a national point of view.

Another suggestion, ventilated in the debate by Mr. Wootton-Davies, was that fundamental research should be organized by some sort of parliament of science—that universities should be represented on some sort of committee or parliament, with some directive force such as a Minister of Science to direct it. This suggestion also was rejected by Mr. Attlee ; but while he rightly said that we need in all departments persons who are trained in the scientific method and appreciate what it means, as well as departmental research, he again failed to deal constructively with a proved need for co-ordination.

If, as Sir Granville Gibson said, it is necessary to plan the application of science to industry, it is no less necessary to plan, not in detail but broadly, the whole of research. The allocation of the Government grant to research as between industrial, agricultural, medical and other research, and pure and applied research, should not be haphazard but planned in accordance with national needs. This was Dr. Haden Guest's argument for making permanent the Scientific Advisory Committee of the War Cabinet.

To Dr. Haden Guest's suggestion that the Scientific Advisory Committee should be asked to prepare a plan for the development and carrying on of scientific research for a ten-year period, Mr. Attlee made no reply ; but in regard to the means by which the effective utilization of research in industry can be secured, his attitude was more reassuring. On this question Sir George Schuster's contribution to the debate was the most important. He emphasized three things : the necessity of creating a more scientific frame of mind in British industry—which means many workers trained in science and a rapid development in all forms of scientific and technical education. Secondly, the closer contact between those engaged in scientific research and those concerned with its practical application—the two-way traffic already referred to ; and thirdly, the discovery of further means of assisting the stage of development and the practical evolution of new industrial ideas. While deprecating some of the comparisons made with the United States, Sir George said that we have much to learn from them ; in particular he referred to the Mellon Institute and its system of industrial fellowships as a method worth consideration by the small firms of Great Britain.

On this point Mr. Attlee stated that the Government recognizes the need for the establishment of some fund to meet the cost of developing new inventions and of providing facilities for testing new ideas for industry. The best way to meet this need and to fit it in with the work of the research associations is now under examination. Mr. Attlee was also careful, however, to point out that Government support for research must be backed by a readiness to use the results of that research. There must be receptive minds in those responsible for the conduct of industry and in the general public. Although the Government can do much to stimulate research, the main responsibility for applied research must continue to fall upon industry itself, and in many industries this is less a question of further expenditure than of assigning to research its proper part and status in the organization.

The personal encouragement scientific workers may well derive from the debate should stimulate them to further efforts in the task of education, no less than to determined thinking about the many difficult problems of organization and co-ordination on which the debate also touched. Certainly there could not have been put into their hands a more convincing demonstration of the dependence of a permanent increase in agricultural and industrial productivity on scientific research, on the speedy application of its results and the training and skill of the working population. The whole nation, as well as industry, must be roused to go forward adventurously and with faith in its future, to seize the opportunities in the post-war world which are so clearly within its grasp.

TAXATION AND RESEARCH EXPENDITURE

A FEATURE of recent reports on industrial research has been the emphasis which has been placed on the influence taxation is capable of exerting upon research expenditure. The Federation of British Industries, for example, has advanced the principle that all expenditure on research and development should be chargeable against revenue, either immediately or over the commercial life of any asset created. This principle was strongly endorsed by the Industrial Research Committee of the Federation, which in its report last autumn referred to the deterrent effect on the expansion of research of any narrow interpretation of what is allowable expenditure for taxation purposes. The London Chamber of Commerce, expressing its agreement with this view, urged further that the cost of pilot plant, as well as of laboratory buildings and equipment, should be made chargeable against equipment. The question has been further examined by the Parliamentary and Scientific Committee, which in a memorandum on Taxation and Research examined the present position and instanced some of the defects of the present system. This memorandum was based on the ideas first that in modern conditions no industry can maintain its competitive position unless it devotes adequate effort and money to scientific and industrial research. This applies with special force to British industry, having regard to the conditions and tasks which will confront it after the War. Secondly, the money required for such research will be substantially greater than in the past. Again, judged by standards in other industrial countries, and quite apart from its own exceptional needs, British industry has in the past devoted far too little effort and money to scientific and industrial research; and lastly, an increase in the productivity of labour, which is one of the main consequences of industrial research, is a vitally important factor in making possible an improvement in wages and social services. The recent debate in the House of Commons on Government provision for research showed that these ideas are widely shared.

The memorandum went on to urge that every impediment to the undertaking of scientific and industrial research by British industry should be removed and inducements provided to stimulate progress. In particular, the memorandum recommended that the law relating to the taxation of profits should be amended so as to recognize the principle that all expenses incurred on research and development are allowable as deduction from taxable profits, with the corollary that receipts from a lease or sale of discoveries should be brought into taxable profits. Expenditure on research which creates a tangible asset with a measurable life, and expenditure on the purchase of patents and processes, should be similarly allowable over a period of years. All other expenditure should be allowable in the year when it is spent. No distinction should be made between pure research and applied research and development. A special writing-off allowance on capital assets provided solely for research purposes was also suggested, as well as the increase of depreciation rates for industrial buildings and plant to include obsolescence by an arbitrary addition to the rates allowed for wear and tear.

Sir John Anderson went far to meet these proposals in his Budget speech, which may well be regarded as something of a landmark in this respect. Recognizing first the supreme importance of appropriate allowances for capital expenditure in relation to reconstruction to enable British industry to meet the post-war challenge, he proposed a special allowance of 20 per cent of the cost of new plant and machinery, and as a part of post-war policy that the obsolescence allowance should be given when plant and machinery are scrapped, whether the particular piece of plant or machinery is replaced or not. With regard to buildings such as factories and buildings associated with them for welfare purposes or storage, he proposed an annual depreciation allowance of 2 per cent with an initial allowance of 10 per cent as an immediate instalment.

Referring to scientific research, the Chancellor of the Exchequer believes there is a case for modifying the distinction drawn for income-tax purposes between capital and revenue expenditure on research. He therefore proposes that any research expenditure of a capital nature, including expenditure on laboratory buildings, plant and machinery, should be allowed for a period of five years, or for the life of the asset, whichever is the shorter, as a deduction from profit for income-tax purposes. Further, any payment, whether for capital purposes or not, made by a trader to a central research body approved by the Department of Scientific and Industrial Research, should be allowed as and when made as a deduction in computing the profits of the concern.

Sir John Anderson, after observing that we should not depreciate our own efforts in the field of research, went beyond these proposals to relieve from taxation funds devoted to research, and expressed the hope that there would be much wider pooling of ideas in the field of research, and that the industrial research worker should be encouraged to regard himself not only as a servant of the organization which pays him, but also as a contributor to the sum total of available knowledge. Referring to chemical industry and the extraction of products from oil and coal, where plastics is only one of the fields opened up, he said that there should be no obstacle placed in the way of chemical industry in obtaining raw materials from oil. He was not prepared to place scientific proposals before Parliament at the moment, but proposed to arrange with the Minister of Fuel and Power for an inquiry to supply the data required for specific proposals.

Following so swiftly on the debate in the House of Commons on Sir Granville Gibson's motion on April 19 (see p. 539), the Chancellor's speech should give the liveliest satisfaction to scientific workers. His speech, no less than his proposals, leave no room for doubt as to the importance the Government attaches to research, or its appreciation of the contribution scientific workers have made to the war effort. That

such proposals and recognition should find so prominent a place in the Budget speech affords firm ground for the hope that scientific workers will be given a full opportunity to play their part in reconstruction, and that the Government is determined to establish the conditions in which scientific and industrial research may make the largest possible contribution to the progress and well-being of the nation.

RHEOLOGY: PRACTICAL AND THEORETICAL

Ten Lectures on Theoretical Rheology

By Dr. Markus Reiner. Pp. iv+164. (Jerusalem: Rubin Mass; London: H. K. Lewis and Co., Ltd., 1943.) 22*s*. 6*d*. net.

A Survey of General and Applied Rheology

By Dr. G. W. Scott Blair. Pp. xvi+196. (London: Sir Isaac Pitman and Sons, Ltd., 1944.) 18*s*. net.

RHEOLOGY probably owes much of its appeal to the fact that it has not yet developed into a fully established science with a generally accepted subject-matter and method of treatment. The study of the "flow and deformation of matter" might include almost anything in Nature, and indeed there are few industries in which problems essentially rheological in character do not arise. These problems frequently have to be attacked by chemists, physicists or engineers whose training has provided them with only a very meagre basis on which to work, and the appearance of two books on rheology by two of the best-known pioneers in this field will be especially welcome to them.

The two authors approach their subject at very different angles. Dr. Reiner, taking the point of view of the mathematical engineer, develops his subject by methods of the kind with which we have become familiar in the classical theory of elasticity. He says, in effect, "These equations represent possible types of behaviour of matter; let us see whether we can find materials which behave accordingly". Dr. Scott Blair, on the other hand, sets out from the experimentally observed rheological phenomena (of which he possesses an encyclopædic knowledge), tries to find equations to represent the data, and hopes that an explanation may emerge.

Dr. Scott Blair shows us that the essence of a rheological investigation is the determination of the relation between the three variables, stress, strain and time. Starting from a consideration of the two extreme 'ideal' materials, the Hookean elastic solid and the Newtonian viscous liquid, he leads up to the discussion of those more complex materials (which are the special concern of rheology) for which both the amount of strain and rate of straining vary with time, under constant applied stress. Such materials combine some of the characteristics of both the solid and liquid states. Altogether there are at least nine main types of deformation (or flow), which are presented in the form of a table, but this is not considered to be exhaustive. Thixotropy, dilatancy, plasticity, false body and a number of other rheological phenomena are discussed in detail, and particular attention is paid to the question of definition of the terms employed. The book contains a full discussion of the significant information to be sought in a rheological investigation, and a critical examination of the experimental methods available. A valuable feature is the inclusion of a comprehensive collection of references, carefully arranged and annotated. (But why Roman numerals for volume numbers ?)

In the second part of the book Dr. Scott Blair deals with a subject which has so far received comparatively little attention by rheologists, namely, the very important practical question of the relation between physical measurements and psychological judgments. The problem confronting the rheologist in industry is to find quantitative methods of assessing properties which the skilled craftsman is in the habit of judging by thumb-and-finger methods. The concepts entering into the judgment are usually mixed, and seldom consciously appreciated. The situation is very well illustrated by the concept of 'firmness', which has been the subject of a special investigation by the author and his collaborators. From the results of this investigation one is forced to conclude that the concept of firmness is not based on a mental analysis of perceptions into concepts of the kind with which ordinary physics deals, such as, for example, average applied force or total strain. The judgment appears to be a direct reaction to the total situation, in which all the relevant components are appreciated as a single integrated pattern or *Gestalt*. Here one is in danger of becoming involved in the philosophical mystery of the relation between the conscious perceiving mind and the external (?) perceived universe. But without going so far, one must recognize that Dr. Scott Blair has brought out the rather fundamental difficulty of what might appear at first sight to be a straightforward problem in rheology, and this presentation of his unique experiments will be generally welcomed.

Dr. Reiner begins his "Lectures" with an analysis of stresses and strains, using tensor notation. He develops the conception of a general rheological equation relating stress and strain and the time-derivatives of these variables. By suitable choice of the terms of this equation, special cases are obtained which represent possible types of rheological behaviour. Arranging the types in order, we have at one end the Euclid (incompressible and undeformable) solid. Then follow the Hookean (ordinary elastic) solid, and the Kelvin (viscous) solid, in which the elastic deformation is subject to a time lag. At the other extremity we have the Pascalian (incompressible non-viscous) liquid, the Newtonian (viscous) liquid, and the Maxwell (elastic) liquid, in which the stress decays with time. The properties of these types are discussed, and compared with actual materials. The intermediate region contains the more complex types, some of which are discussed in detail. The table may be compared with the rather similar table of deformations given in Dr. Scott Blair's book.

A number of special problems are considered, including, in particular, the theory of breaking. It is shown that a Kelvin solid breaks when the *strain* reaches a given value, while in a Maxwell liquid failure occurs at a critical value of *stress*.

It would appear that in respect of purely elastic strains, the tensor methods used in this book are applicable only when the strains are small. Many rheologists would like to know what methods to apply in the case of large deformations.

Both the works under review, which are in a sense complementary, should be studied by all who are interested in rheology. L. R. G. TRELOAR.

THE ART OF THE OPTICIAN

Optical Workshop Principles

Being a translation of "Le travail des Verres d'optique de Précision", by Col. Charles Dévé. Translated by Thomas L. Tippell. Pp. xiv+306. (London: Adam Hilger, Ltd., 1943.) 20*s.* net.

IT may at first sight seem surprising that a second book on the grinding and polishing of lenses should have been published by Hilger's so soon after their publication of "Prism and Lens Making" by Mr. Twyman. But there are at least two reasons which justify such a course. In the first place, lens-making is a craft, and each craftsman's account of his experience has something of value to every other craftsman. In the second place, the author is a Frenchman, and it is much to be desired that information about the techniques employed in one country should be made available in other countries. It is a novel experience to find the names of pioneers turn out to be names of Frenchmen rather than Britons, while the sources of specially suitable material or apparatus are quoted as French rather than English.

The book is based on the instruction given at the Institute of Theoretical and Applied Optics, Paris, to students of optical glass-working, and Part I is specifically addressed to working opticians. Part II is of a somewhat more advanced character and is intended primarily for works managers and senior workmen engaged in the supervision and direction of high-grade optical work. There is a great deal of useful information in the various sections, from recipes for cements and details about abrasives and polishers to methods of testing by interference and otherwise and to processes of etching, silvering and so forth. But by far the most important part of the book is concerned with the mechanical problems involved in producing a surface of given shape and curvature.

It is no easy matter to evaluate the relative effects of the different motions, rotational and translational, of either the tool or the work on the shape of the surface being ground, yet without some knowledge of the underlying principles, the average workman may easily go astray when he is put to a novel or unaccustomed task. The chapters dealing with the production of spherical and cylindrical surfaces, the effect of the size of tool, the pressure to be exerted, the surfacing of lenses of deep curvature, retouching, thermal deformations, working of metallic mirrors and so on, which include several theorems regarding the distribution of wear under various conditions, are a valuable contribution to the art of lens-making. An unusual, though not unwelcome, feature in a book of this type is the inclusion of a number of exercises to demonstrate the application of the principles which have been described.

It is somewhat surprising to find that the author has not dealt to any serious extent with the nature of the action of the abrasive on the surface of the glass during grinding and polishing. Even if the actions of the workman cannot be adjusted to modify the character of a ground or polished surface, it would have been interesting and instructive to learn whether the author considers, for example, that the polish on a surface arises from thermal flow or from extremely fine abrasion.

The translator is to be congratulated on his English rendering of the text, and on the useful vocabulary of French technical terms with their English equivalents. The footnote which he has added as a correction on p. 224 is itself in error; but in general the book would seem to be commendably free from mistakes.

As the translator remarks in his foreword, it was unfortunate that owing to the War the author and translator were not able to exchange ideas, as this might have allowed for the omission, or amending, of one or two passages which to an English reader may well seem too simple and naïve; this would apply, in particular, to the opening paragraphs of Chapter 1. But without the author's authority any such amendment would obviously be unwarranted.

W. D. WRIGHT.

WATER PURIFICATION

The Purification of Water Supplies

By George Bransby Williams. Pp. 95. (London: Chapman and Hall, Ltd., 1944.) 7*s.* 6*d.* net.

THE appearance of a book on the purification of water supplies is most opportune at the present time when it is generally realized that all is not well with the water supply of Great Britain, especially the supply in rural districts, and when it is recognized what an important part water will have to play in the reconstruction problems with which the country is faced.

The author has attempted too much in too short a space. He has, in less than twenty pages, attempted to give a review of the principles of chemical science as evolved from the time of the Egyptians thousands of years ago, through Grecian, Roman and Arabian knowledge to the work of the Curies and of J. J. Thomson and Rutherford on the electronic structure of the atom. Such an attempt might well have proved disastrous; but not so in this case, and a readable chapter has resulted.

The book is arranged in eight chapters, each dealing with one or more aspects of the material considerations which arise in order to render a natural water fit for human consumption. These various aspects are enumerated rather than explained, and the experience of American and Indian practice is drawn upon very largely, while the accumulation of knowledge acquired by British practice is drawn upon to a less extent.

The chapter dealing with colloidal matter in water can only be described as sketchy, and in the chapter dealing with chemical precipitation the theories of coagulation and flocculation are inadequately explained.

The book serves a useful purpose in directing attention to the various points which must be considered when subjecting water to purification processes, and in stressing the fact that efficient scientific control of all operations connected with purification of water supplies is essential. Water purification is not a matter for the amateur, but is a subject which deserves far more co-operative attention from the engineer, the chemist and the biologist than it has received in the past.

A more careful proof-reading would perhaps have added to the value of the book. For example, Fig. 4 on p. 52 should have referred to the "accelator" type of water softener and not to the "accelerator" type; sodium bisulphide (p. 76) is not used for dechlorination, but sodium bisulphite has been so used. It would have been possible to make a better selection for the eleven illustrations in the text.

H. T. CALVERT.

THE WELLCOME–MARSTON EXCAVATIONS AT LACHISH, PALESTINE*

By OLGA TUFNELL

THE broad purpose of archæology is to increase our view of history. The field archæologist works for the historian; together they try to extend our line of vision, to indicate fresh points of view and fields of inquiry, and to sketch in the background and elaborate the detail of the known historic scene.

We owe our knowledge of Egyptian and Mesopotamian history almost entirely to recent archæology, but the history of Palestine has been preserved for nearly four thousand years, and is a unique means of control for archæological data, which can be checked against Biblical tradition.

The geographical position of Palestine makes it a land bridge connecting Asia and Africa. Many people left traces of their passage and assimilated something of the countries they passed through. Experience has shown that, if we are to assess cultural connexion or influence, style of decoration is more reliable than form or technique. Shape and method can be re-invented, but style is an æsthetic expression which in its less primitive stages shows marked individual characteristics. Thus the potsherd is sometimes more important than the palace, but all material remains add something to the perspective of the past.

With these thoughts in view, it was the intention of the expedition which became the Wellcome–Marston Archæological Research Expedition to the Near East to tap the lines of communication across the land bridge at strategic points, and to follow them in whatever direction they might lead.

Sir Henry Wellcome with Sir Charles Marston, Sir Robert Mond and Mr. H. D. Colt first considered the choice of a site in 1932, and the possibilities were discussed with Mr. J. L. Starkey, who became director of the Expedition, which set out in the autumn of that year. The choice of a site as a control point is influenced by practical considerations, water supply, accessibility, expense, quite as much as by geographical position and historic importance. Among the sites considered, Tell ed Duweir seemed to fulfil the requirements, though the soil was much encumbered by heavy limestone blocks, and the area of eighteen acres obviously required many years of systematic work. The promoters of the Expedition did not hesitate to undertake the task, trusting in Mr. Starkey's great abilities.

It is immaterial whether or not Tell ed Duweir can be definitely identified with Lachish. Its central position in the Shephelah, on the main Gaza–Hebron road, between Gaza and Jerusalem, shows that it must have been an administrative town of importance throughout its long history from the Early Bronze Age—say about 3000 B.C.—to the Persian conquest about 400 B.C. The lack of Greek and Roman remains facilitates excavation and was apparently due to a reorganization of the road system when the point of intersection of various routes was shifted to Beit Jibrin.

The Early Bronze Age appears to have been the most flourishing era at the site chosen. The extension of a limestone ridge, surrounded on three sides by valleys, which later became a 'Tell' or mound through the accumulation of debris, was already occupied. The circle of adjoining hills and the lower slopes of the mound were thickly pitted by caves, artificially enlarged, where a troglodyte population lived and traded outside any line of defence which may have existed on the crest of the ridge itself. The extent of the area covered by these dwellings is approximately 200 acres; so vast a centre of early life is unusual in Palestine, and the contents of these caves are easily exposed, in contrast to the stratified levels on the mound, which are below 45 ft. of town deposit. In order to obtain a connected view of events, as illustrated by the sherds, two sections were examined. The lower 10 ft. at the north-east corner probably date from the fourth millennium, and could reveal much that is new and foreign to local culture.

Some hundred and fifty pottery forms have been drawn and recorded from the cave dwellings, and they should add their quota to the steadily increasing knowledge of the Early Bronze Age, in which four distinct phases can now be recognized.

In common with observations from other sites, we note a tremendous cleavage in cultural affinity at the beginning of the Middle Bronze Age at Tell ed Duweir. The people dwelt in houses and built walls around them; the caves were often used as burial places. There is a total change in pottery technique, and a marked increase in the use of copper, which had already made an appearance in the transitional stage—only represented at Tell ed Duweir by a series of poorly furnished tombs. Scarabs were added to the equipment of the dead, and among the daggers one was found to be inscribed. Apart from many incised marks on Early Bronze Age pots, this is the earliest inscription yet found at Duweir, and it is close to the Sinaitic script associated with the origin of the alphabet.

For the first time, a system of defence became necessary, either against the dissatisfied remnants of the previous population, or against further newcomers of the invaders' kin. So far as we know, the earliest method of defence at Tell ed Duweir (though excavation may reveal an earlier one) consisted of a fosse some 8 m. broad, cut in the limestone, while the material taken from it was piled against the natural scarp of the mound to form a slope or glacis. It has been examined at the north-west corner of the mound, where the slope was cut into by the Iron Age city wall. But it was a fortunate position, for after clearance of the packing, a small oval grave was discovered, cut into the native rock. The body was immature, and the group of pots and bowls were all distinctive types. The position of the grave, and its relationship to the layers of thrown limestone from the excavation of the fosse, leave no shadow of doubt that it preceded this engineering work by some years.

Since Sir Flinders Petrie's excavations at Tell el Yehudiyeh, a small fort to the east of the Nile Delta, where he first discovered fosse and glacis fortifications, it has been assumed that the people who built them were also responsible for a particular kind of black pricked ware and 'button-base' juglets found at the site. The people known as 'Hyksos' or 'shepherd kings' set up a foreign dynasty in Egypt lasting about two hundred years, towards the end of the Middle Bronze Age. On comparing the evidence from Tell

* Substance of a Royal Institution discourse delivered on February 18.

Fara, south of Gaza, it is significant that in the graves of the period no button-base flasks were found, either of the red burnished or black pricked ware, though the typical fosse and glacis defences existed.

As Mr. Starkey pointed out in 1933, there is some further evidence provided by a decorated pot, found with a mass of other pottery on bedrock in the fosse. It is therefore undoubtedly later than the oval grave and the fortification. The decoration compares with similar motives, notably the bird and fish, from other sites in south Palestine and in Syria of the same period, about 1600 B.C., and the style of drawing in both areas is similar.

Prof. Speiser, in his account of excavations at Tell Billa on the Orontes, has directed attention to the duplication of the whole repertoire of decorative motives found at this period in Palestine in level 4 of his site. In addition, the cuneiform correspondence from Tell el Amarna, and Ta'annek in Palestine, reveals the presence of governors and officials with names of non-Semitic origin, belonging to the dialect used by this Hurrian people from north-east Syria. Prof. Speiser suggests that the Hurrians as represented at Tell Billa (3) were conspicuous among the later 'Hyksos' groups. They were possibly the dominating class in Palestine before the Hebrew invasion, and if so, it would account for the loyalty of some of Egypt's local governors, during the troubled times which are so dramatically described in the Tell el Amarna letters.

It seems that we are gradually acquiring the facts in south Palestine which will enable us to differentiate between the influence of the so-called 'Hyksos' people and that of the non-Semitic Hurrians, who figure so largely in the ethnic movements north of Palestine in the second millennium.

The relationship between the Yehudiyeh pricked ware, the fosse and glacis, and the three structures of the Fosse Temple (the contents of which were published in a volume of that name in 1940) will assist in this intricate problem. The actual position of the temple on the disused fosse emphasizes the intrusive nature of the cult, and we have yet to discover the earlier centre of worship, which presumably occupied a prominent position on the mound.

A point which links the Fosse Temple cult to that of the Hebrews in the following century is that the sacrificial bones found in the structures were almost exclusively those of the right foreleg; sheep (or goat), ox, and two wild beasts, gazelle or ibex, were represented. In the Mosaic peace-offering the right shoulder was offered before the altar and retained by the priest, and this ritual was also observed by the Babylonians.

Of objects with foreign connexions from the Temple deposits, I should mention the 'lion hunt' scarab of Amenhetep III, who reigned between 1411 and 1375 B.C. Duplicates have been found in many provincial centres, and they record that the king killed "lions terrible, 102, by the 10th year of his reign". It was found on the altar of Structure III, but in common with the ivories and glass associated with it, these temple treasures seem to have been preserved since the enlargement of Structure I. Its presence at Duweir marks the point of junction with Egyptian written records and opens their rich annals of imperial expansion.

A Mykenæan cup (1500–1400 B.C., according to Helladic sources) is the first link with that culture, and it formed part of the altar-group belonging to Structure I. Some twenty-five forms are identical with the wares usually attributed to Cyprus and Syria.

The development of the temple can be traced through two hundred and fifty years of comparative peace and growing prosperity. The earliest structure was founded about 1475, and the third building, greatly enlarged, was destroyed by fire with most of the temple equipment about 1223 B.C., on evidence provided by a cartouche of Rameses II. This destruction also overwhelmed the Bronze Age town; indeed, most of the contemporary cities of Palestine and Syria were involved in a similar catastrophe.

There is nothing to show from Duweir as to the force which effected the destruction. It was only gradually that the life of the city was resumed, and it is likely that foreign trade connexions were not so flourishing as they had been in the late Bronze Age town, when examples of threē scripts, Sinaitic, hieroglyphic, with its cursive form hieratic, were in contemporary use, quite apart from cuneiform which also occurs in south Palestine.

From the beginning of the Iron Age other sources of written record become helpful. The Old Testament is full of administrative detail, and it is clear that the officials of the time were occupied in problems of local defence, particularly after Solomon's death about 935 B.C. Rehoboam, his son, fortified fifteen cities in Judah, and Lachish, with its neighbour Azekah, among them.

An inner and outer stone wall still encircles the mound at Tell ed Duweir. Though it is battered and burned, the line can be traced without a break. The upper courses were built of brick, and both brick and stone surfaces were faced with a coat of white lime plaster. Though this system of defence may have been intended as protection against Egypt, there is good reason to attribute the signs of the first attack to the invasion of the Assyrians under Sennacherib about 700 B.C. The commemorative relief in his palace at Nineveh, found by Sir Henry Layard, shows the assembled might of his army before the city of Lakhisha. The method of attack is shown in great detail, and at Tell ed Duweir we see corroborative evidence of some similar event; we find sling shots, fragments of scale armour, a helmet crest and arrowheads in profusion.

A cave had been used about this time as a repository for skulls; they had been thrown in through a hole in the roof and many had rolled down the conical heap to the sides of the chamber. The bodies had been moved to this cave after disintegration, and a few skulls showed signs of burning. The series of seven hundred skulls has been studied by Mr. D. L. Risdon with Dr. G. Morant of the Galton Laboratory. The adults were younger on the average than the usual cemetery population, which gives colour to the supposition that they died in a catastrophe. Mr. Risdon's statistics place the Lachish series in close connexion with the contemporary Egyptians, with two differences.

Sir Arthur Keith, in a valuable article published in the Palestine Exploration Fund Quarterly Statement (January 1940), wrote as follows: "Mr. Risdon notes among the Lachish people two characters which are non-Egyptian, namely narrowness and prominence of the bridge of the nose and curvature of the cheek-bones. From these characters alone I should have suspected that the Lachish people were

racially different from the Egyptians." Sir Arthur referred to the Lachish series as "the first complete account of the racial characters of a people living in Palestine during biblical times".

In the same depository of skulls, three examples were found to be trephined. This operation was common so early as neolithic times in Europe, North Africa and even the two Americas. It is also practised by primitive people to-day. The specimens from Duweir are unique, being the only ones so far discovered in the Near East, and their presence shows once again the many influences which affected the coastal strip. It is not possible to say whether the operation was therapeutic or magical. Two methods occur at Duweir: one was removal of the disk by cross cuts, as seen in two skulls where the sharp edges indicated that the patient died shortly afterwards, and there is a triangular type more akin to the European method of scraping, which gave the patient a better chance of recovery.

The Babylonian campaigns which mark the virtual end of the city are well attested both in their own and Biblical records. The period between 700 and 600 B.C. is represented on the mound by a district of shops and houses protected by a city wall which had been repaired since Sennacherib's attack. The Babylonian commander was aware of the perils of leaving partially destroyed fortifications, and he burned long sections of the wall by heaping great piles of olive trees and brushwood against them. In the charred debris, we still find the calcined olive stones which show that destruction took place in the autumn just before harvest time.

At the gate of the city, in the guard-room of this last period of fortification, while sorting a mass of blackened sherds, Mr. Starkey with Mr. Harding found the now famous "Lachish Letters". They form an invaluable link with the Bible record; for the first time we can study the handwriting of contemporaries of the prophet Jeremiah, written in the beautiful pre-exilic script, which is allied to our own alphabet through the Phœnicians. Dr. H. Torczyner, who undertook the publication of the letters, has noted many Biblical names and directs attention to phrases which have all the flavour of Old Testament language. Letter IV includes the sentence, "if in his turning (on his rounds) he had inspected, he would know, that for the signal stations of Lachish we are watching, according to all the signs which my Lord gives, because we do not see (the signals of) Azekah". These words imply that Lachish and Azekah were still linked in the same system of defence as in King Rehoboam's reign.

The defences of Duweir were finally broken about 600 B.C., but the town enjoyed a short period of revival during the Persian occupation. The Persian residency crowned the site for a few years, and was built on the massive foundations of the earlier Judæan fort.

In presenting the shadowy traces of the many peoples who passed by, it is hoped that in years to come some one will carry forward the work which James Leslie Starkey began.

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MUSCULAR AND MENTAL RELAXATION IN PEACE AND WAR*

By Dr. E. J. BOOME

RELAXATION means more than just a holiday or a lazy time; it means concentration and not inertia.

The relaxation of muscular exercises, in moderation, re-creates the body and conduces to physical fitness, which is one of the chief bases of mental poise and well-being. But relaxation is much more far-reaching in its effects and more constructive in its processes. Beginning with a muscular loosening, it leads to a gradual re-creating of the individual. This form of self-treatment, apparently very simple, is more complex than is realized by the beginner.

Everyone feels the state of tension in the world to-day and the need for some antidote to counteract it. This tension—always in the world even in time of peace—is greatly aggravated by war conditions. In individuals it is expressed by muscular hypertonicity, in mental worry, fear, anxiety, in emotional repression and nervous strain. These factors sometimes react upon each other and cause a breakdown.

Nervous cases tend to become more frequent in days of fear and anxiety such as we have all been through during the past four years. Some people come back automatically to normal, but others do not. Often the attitude of friends and relations intensifies the feelings of these people. Even medical men sometimes say: "There is nothing wrong with you, it's only your nerves or your imagination". Nowadays, we are more careful because we realize that such an attitude only makes these patients ponder more over their ailments, imaginary or otherwise. This makes matters worse, as they become almost convinced that there is really something wrong with them and turn to patent medicines which claim to cure all their ills.

Annie Payson Call, in her book "Power Through Repose", very wisely said:

"Where is the good of taking medicines to give us new strength, while at the same time we are steadily disobeying the laws from the observance of which alone the strength can come ? No medicine can work a man's body, while the man's habits are constantly counteracting it. Where is the use of all the quietening medicines if we only quiet our nerves in order that we may continue to misuse them without their crying out ? They will cry out sooner or later."

In order to prevent this, we must first investigate the causes of hypertension.

The body reacts on the mind and vice versa. This happens in cases of real illness, particularly if the patient has never been ill before. He gets anxious about his condition and even becomes angry with himself for being ill. This sets up and increases mental and muscular tension and retards recovery. A cheerful patient, on the contrary, generally recovers more quickly.

Work never killed anybody, but the *worry* which is added to and mistaken for work has caused many a breakdown. In war-time there is often the element of fear added, which increases the wear and tear of one's daily occupations. Many people waste 50 per

* Substance of a Chadwick Trust Lecture delivered on October 5 at the Royal Institute of Public Health and Hygiene.

cent of their efficiency and adversely affect the environment of those working under them because of their own anxious temperaments. Often they cannot see the harm they are doing to themselves and others and scornfully refuse any suggestion of treatment.

In Great Britain 20,000,000 are employed, many on war work. 40,000,000 weeks a year are lost from sickness, of which it is estimated that we lose 8,000,000 weeks of work a year through gastric and nervous disorders. Many so-called gastric disorders are not due to disease of the gastro-intestinal tract but to functional dyspepsia—an emotional disturbance which shows itself by gastric disturbances. A similar proportion of imagined 'nervous dyspepsia' found among civil defence workers (ambulance, fire brigade and rescue services) clear up with a change of scene and rest.

War-time restrictions which control the lives of 8,000,000 civilians give a sense of frustration, and may cause nervous illness and anxiety in some people. This discontent and frustration caused by war-time conditions may be alleviated by the Ministry of Labour schemes for 'rest-break' homes for war workers. These are to be greatly extended, and soon a network of these hostels will be established throughout Great Britain. Pamphlets such as "Fighting Fit in the Factory", explaining the necessity for rest whenever possible and telling workers the best way to relax, can help.

Much is being done by the Ministry of Labour and National Service to make the life of the workers as harmonious as possible.

Some so-called 'authorities' say that complete relaxation is impracticable in everyday life. It is not only practicable but also desirable. The complete process is obviously not possible in all circumstances and places, but we need not use so much unnecessary muscular energy in the ordinary ways of life, such as clenching the jaw when writing or pushing against the floor with the feet when riding in a bus. Legs should sometimes go 'off duty'.

Relaxation in Crafts and Sports

Most crafts and sports depend upon rhythm to attain the best results. Rhythm again depends on correct timing, which can only be carried out by muscular balance. This is brought about by alternate muscular contraction and relaxation. The excitement of some forms of sport may cause hypertension, and the more this increases the less efficiently are the necessary movements carried out.

In yachting the helmsman must have complete muscular control to steer a steady course, as well as being mentally wide awake to take decisions and give orders to his crew.

Rhythmic timing is shown in such diverse sports as boxing and fishing, while success at golf and many other sports depends on accurate timing.

Eric Linklater in the "White Man's Saga" gives a beautiful description of the boxer. He says:

"There is beauty in boxing when men stand upright and step lightly. There is design in their movements, and significance as charged as that of the ballet. Counterpoise follows on poise, defence on attack, reaction on action with a balance, a trim symmetry that quickens as the blood beats and grows and swells into a pounding orchestration of thudding fists and shifting, sliding feet; for an instant there is repose, the sculptured austerity of two figures, motionless, poised like statues on the verge of life; and then their static energy is again released to mingle dynamically in a crescendo of action".

Tobias Matthay in "The Visible and Invisible in Piano Technique" emphasizes the important changes of state of exertion and relaxation of the playing limb which form the real basis of good technique, but which, being invisible, have escaped attention.

Physiological Facts with Regard to this Thesis

Resting muscle is alkaline, whereas over-worked or fatigued muscle contains lactic acid. The amount of the latter is in proportion to the amount of tension.

Pain and violent emotion of any kind such as anger or fear cause chemical changes by releasing toxic substances and excessive glandular products into the system, which have to be carried away and thrown out by the blood stream into the channels of excretion. Excessive adrenalin in the blood may lead to vascular troubles and other harmful conditions unless dissipated either by action or muscular relaxation.

Long-distance runners are massaged so that the muscle gets rid of its waste products more quickly. Return flow of blood to the part is increased after contraction and relaxation, so circulation is increased.

Medical Examination

Muscular relaxation is of the greatest assistance in medical examination. If a candidate for superannuation and pension or life insurance presents himself before the medical examiner strung up to a state of tension, he will show signs of quickened heartbeat and his chest will tighten up with inhibition of breathing. He may stand stiffly to attention, thinking he is thus making the best of himself, which causes his blood pressure to go up under the strain he makes himself undergo. If the medical man can persuade him to relax the task is much simpler, time is saved and the candidate feels happier. A 'bedside manner' really is a useful, if not an essential, asset to a medical man. It means he is himself relaxed, has poise and can thus command confidence.

Often the practice of relaxation can cure stammering and relieve high blood pressure.

Stammering

This distressing condition was one of the reasons I became interested in relaxation. In 1919, I was placed in charge of centres for stammerers. In those days we used only voice training and speech drill, treating the symptom and not the cause, and the results were depressing.

Psychological and temperamental readjustments are of great importance in the treatment because the stammerer's outlook on life in general and himself in particular is depressed and usually negative.

Relaxation calms and reassures the sufferer and enables him to carry out his day's work quietly and efficiently. All his characteristic symptoms of tension disappear and he becomes a strengthened, stable and self-respecting person, ready to face the world with confidence.

Asthma is a nervous complaint rather like stammering. Good results are obtained by relaxation therapy in these cases, and diminution in frequency and severity of attacks follows treatment. The nervous tension and anxiety so frequently found in these cases are much diminished. The breathing becomes easier, confidence is restored and the distress is abated.

With regard to birth palsy, I have seen excellent results with muscular relaxation for the paralysed limbs. Relaxation seems to give increased confidence, with consequent improvement in gait, and also to make the best use of the injured muscle.

In cases of tennis leg and tennis elbow, relaxation is an important part of the treatment.

According to the late W. Trethowan, 85 per cent of cases of spinal curvature are due to functional nervous disorder and are not indicative of any organic disease. This condition usually denotes that a larger call is being made on the child than its general physique will stand. It is often found during adolescence and may be associated with enlarged tonsils, adenoids, constipation or over-pressure in study.

Attention to the general health usually results in the disappearance of the defect. Early cases of spinal curvature respond better to a midday rest in the recumbent position than to exercises. It is useless to try to heal the muscles by working them. Muscular relaxation practised under expert guidance is of untold value ; it not only rests the patient but also is definitely curative in effect.

An elementary school teacher of great experience told me that children suffered less when the *Blitz* was at its height, because they were in the shelters early and went to sleep. During later raids they no longer went to the shelters regularly but played in the streets and went to bed late. When the sirens sounded they were got out of bed, with resulting greater fatigue and emotional disturbance. In one day raid in 1943 there were bombs and machine-gunning in the streets which caused an increased amount of tension at the time and delayed progress in relaxation therapy at some of our speech centres. On the morning after the winter raids of 1943 it was interesting to notice that the children relaxed voluntarily for a much longer time than usual.

The evacuation of school-children has shown that far more children suffer from enuresis than was generally supposed. Some cases are the result of neglect in training, but the majority are attributable to nervous causes. Some children develop this habit on being evacuated to the country, but in many cases it stops if the child settles down happily. If the enuresis is of long standing and the child is unhappy, it may be necessary for the case to be sent to a special hostel, though it is doubtful whether this segregation is satisfactory in all cases. A nervous, sensitive child may develop a sense of shame difficult to eradicate even after the enuresis has been cured.

Stammerers suffering from enuresis have been cured of this habit through relaxation, and cases have been known where the enuresis has ceased after one week's attendance at a centre.

In the case of writer's cramp, there is, in addition to the physical condition, a psychological factor. These cases are helped greatly by relaxation.

Dr. Grantly Dick Read says that pain in child-birth could be largely eliminated if mothers were trained to relax from the fourth to fifth month of pregnancy for a few minutes each day. So much pain in normal child-birth is due to a misapplication of the sense messages of fear to the brain, which leads to a tension of the fibres.

Conclusion

Relaxation in some form has been known throughout the ages. Even animals and plants relax for specific periods.

Primitive races still instinctively use it, and ancient races of the East have never ceased to practise it, perhaps because their civilization is of longer duration than ours and was arrived at more slowly.

There is nothing new in the art of relaxation, and its complete story has yet to be told. It is not the panacea for all ills, but it can alleviate physical, nervous and emotional conditions.

The inner peace and tranquillity that may be developed by means of relaxation may pervade a man's life ; so that we can still say with the Psalmist : "Commune with your own heart upon your bed, and be still".

SYNTHESIS OF NEW SPECIES OF WHEATS*

By Dr. ANTON ZHEBRAK

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As generally known, the species of wheats existing in natural conditions are classified into three chromosome groups of 14, 28, and 42, according to the number of chromosomes in their somatic cells. The most widespread species represented by a great number of varieties of races, biotypes and agricultural sorts is the bread wheat *Triticum vulgare*. This species is the most polymorphic and is represented by spring as well as winter sorts of wheats. The record frost-resisting agricultural sorts are found only among *Triticum vulgare*, which belongs to the group with the highest number of chromosomes.

The fact that a number of very valuable agricultural and biotypical qualities has developed in the process of evolution among the highest chromosome species of wheats *T. vulgare*, supports the chromosome that the high chromosome species are undergoing evolution and adapting themselves to various conditions of environment more rapidly than the species with a low number of chromosomes. Hence the problem of introducing wheats into new areas might best be solved by increasing the number of chromosomes. The above, as well as a number of purely theoretical considerations, led us to take up the question of obtaining high chromosome forms of such an important cereal as wheat. However, as most species of wheats are already polyploids, no more valuable and more fertile types can be obtained by an increase in the number of chromosomes in pure wheats, as this would probably lead to highly sterile forms.

We therefore began our effort to obtain high chromosome forms of wheats by doubling the number of chromosomes of interspecific hybrids and not that of pure species.

We selected two species of wheats for hybridization, namely, *Tr. monococcum* and *Tr. Timopheevi*. Both these species are immune from a number of fungal parasites and insects and, what is most important, they have isolated chromosome complexes producing, when crossed with other species, absolutely or highly sterile hybrids. By increasing the number of chromosomes of such highly sterile hybrids we restore fertility and obtain amphidiploid types with higher numbers of chromosomes than those of the parental species of wheats.

* A report on this work was made by Dr. Anton R. Zhebrak in 1940 at the December session of the Timiryasev Agricultural Academy, in 1942 at the November session of the Academy of Science of the U.S.S.R. in Tashkent, and was repeated at the s ssion of the Timiryasev Academy in March 1943.

We began our research into methods of obtaining amphidiploids of wheats in 1936. At first, in order to increase the number of chromosomes, we used various agents—chemicals, temperature, X-ray treatment, etc.—which had been employed by numerous scientific workers prior to us. Unfortunately these agents did not lead to the desired results. Only in 1938, after the publication of the work of Blakeslee and Avery on obtaining polyploid forms among plants by colchicine treatment, did we succeed in obtaining the first amphidiploid types of wheat. At that time we had obtained hybrid seeds of the following combinations: *T. durum* Desf. × *T. monococcum* L., *T. polonicum* L. × *T. durum* Desf., *T. durum* Desf. × *T. Timopheevi* Zhuk., *T. persicum* Vav. × *T. Timopheevi* Zhuk.

In the spring of 1938 we treated hybrid seeds of the above-mentioned combinations with a 0·1 per cent colchicine solution and obtained amphidiploid spikes from the following hybrids: *T. durum* Desf. × *T. monococcum* L., *T. durum* Desf. × *T. Timopheevi* Zhuk., *T. polonicum* L. × *T. durum* Desf.

The amphidiploid spikes *T. durum* × *T. monococcum* and *T. durum* × *T. Timopheevi* were of normal fertility and widely differed from the sterile amphihaploid spikes. We found forty-two chromosomes in the somatic cells of the amphidiploids *T. durum* × *T. monococcum* and fifty-six chromosomes in the amphidiploid *T. durum* × *T. Timopheevi*.

The spikes of *T. polonicum* × *T. durum* hybrids which had been subjected to treatment with colchicine solution in the seed stage contained various numbers of grains: 7–10 and 25–30. Next year (1939) the plants obtained from ears of various fertility were investigated. It was discovered that the ears with low fertility contained amphidiploid grains giving 56-chromosome plants, while spikes with a high fertility gave plants with twenty-eight chromosomes. Thus on the basis of these investigations we ascertained that in the highly sterile *T. durum* × *T. monococcum* and *T. durum* × *T. Timopheevi* hybrids the doubling of the number of chromosomes led to the restoration of normal fertility while the increase of the number of chromosomes of normally fertile hybrids of the first generation of *T. polonicum* × *T. durum* produced polyploid plants of low fertility. We are continuing experiments with them, however.

The amphidiploids *T. durum* × *T. monococcum* have forty-two chromosomes in their somatic cells and occupy an intermediate position between *T. durum* and *T. monococcum*. We consider this amphidiploid a new species of wheat and have named it *Triticum Edwardi* Zheb. The characteristic peculiarities of this species are the intense greenness of the sprouts and the adult plant, the erectness of the stems and their high tillering, the lack of pubescence (hairlessness) of its glumes. The glumes are triangular with blunt crenature. Spikelets are arranged along the stem in a straight line. The side of the ear is wider than the front. The kernel is large and somewhat asymmetrical.

We have classified the amphidiploid *T. durum* × *T. Timopheevi* (2n=56) as new species, *Triticum soveticum* Zheb. In 1939–40 we obtained such 56-chromosome types by crossing *T. Timopheevi* with numerous sorts of nineteen varieties of *T. durum*, six varieties of *T. turgidum*, three varieties of *T. persicum*, three varieties of *T. polonicum* and one variety of *T. orientale*.

Thus 56-chromosome amphidiploid types have been obtained from crossing *T. Timopheevi* with thirty-two varieties belonging to five 28-chromosome species. As there is no great difference in external morphological characteristics and all the above-mentioned amphidiploid types may be easily crossed among themselves and contain the same number of chromosomes, we have classified them as a single botanical species *T. soveticum* Zheb. The amphidiploids of different varieties of *T. durum* × *T. Timopheevi* will form the respective varieties of the new species *T. soveticum* ssp. *durum* Zheb., and similarly for other crosses. Thus the species *T. soveticum* Zheb. obtained experimentally is represented by five sub-species and thirty-two varieties. The number of varieties can be increased by mutational changes, as well as by taking advantage of the variability of the hybrid by crossing different sub-species of *T. soveticum* between themselves. We effected such crossing in 1942.

The most characteristic and general attributes of all sub-species of *Triticum soveticum* Zheb. are the following: dark green pubescent shoots, erect bush and dark green colour of the stem and entire plant. The leaves are pubescent. At the base of the leaf the plant has a ligule and auricle. It possesses high tillering capacity. The spike stem does not break easily. The glumes of the spikelets are pubescent. The colouring of the spikes varies: white, red, black and intermediate shades. The grain is red, glassy, large and long—8–12 mm. The absolute weight of a thousand grains is about 100 grams. This species varies widely in all combinations. It has 56 chromosomes.

The amphidiploids of *T. Timopheevi* with different species of 28-chromosome wheats occupy the intermediate position between *T. Timopheevi* and these species. But as they differ widely from the original species in many characteristics, their number of chromosomes and their ability to cross, we place them in the new species, *T. soveticum*, but in designating the sub-species retain the name of the original 28-chromosome species with which the crossing with *T. Timopheevi* was performed. The peculiarities of the varieties of the 28-chromosome wheats in *T. soveticum* are not always apparent owing to the prevalence of a number of morphological characteristics of *T. Timopheevi*.

The new properties of the amphidiploid types of wheats are: (1) the exceedingly large absolute weight of the kernel, which greatly exceeds that of the parent species (1,000 selected kernels of various combinations weigh between 100 and 110 gm.; the weight of a thousand average grains is about 80 gm.); (2) the amphidiploid species have a longer vegetative period than their parents; (3) various amphidiploid combinations such as sub-species *durum*, *turgidum*, *orientale* have acquired the ability to survive the winter in Moscow.

A new type as regards the number of their chromosomes are the amphidiploids *T. vulgare* × *T. Timopheevi* and reciprocal crossings. Such amphidiploids are obtained from the following varieties of *T. vulgare*: *lutescens*, *milturum graecum*, *alborubrum*, *albidum* and *erythrospermum*. These varieties include spring as well as winter forms. The amphidiploids resulting from crossing with the winter sorts of *T. vulgare* are spring wheats with late ripening. The fertility of these amphidiploids is not high, usually one or two kernels per spikelet. They have seventy chromosomes and belong to the decaploid group. The amphidiploids vary greatly in their morphological characteristics and the length of their vegeta-

tive period. We have classified them as a separate species called *Triticum Borisovi* Zheb. The basic peculiarities of this type are the dark green colour of the shoots, the pubescence of the shoots and leaves and the glumes of the spikelets. The stem of the spike is only slightly brittle. The grains are tightly wrapped into flower paleæ. The number of chromosomes is seventy.

We have also obtained 70-chromosome amphidiploids from crossing *T. durum* × *T. vulgare*. Their fertility is not high but they differ in their morphological characteristics. In some combinations the kernel is good. A more complete account of these amphidiploids will follow later upon completion of more extensive research.

Both the 70-chromosome amphidiploid types have a common peculiarity: their lower fertility as compared with the 42- and 56-chromosome types.

In conclusion, I wish again to stress that colchicine is exceedingly effective as a factor in increasing the number of chromosomes. This is shown by the facts outlined in our work, from which it may be seen that, in a brief period, we succeeded in obtaining more than ninety amphidiploid types of wheat belonging to the three chromosome groups 42, 56 and 70, which may be considered as new botanical species. To the best of our knowledge these amphidiploid types of wheat have been obtained for the first time, and amphidiploids in general, in such large quantities, also for the first time.

OBITUARIES

Dr. J. K. Roberts, F.R.S.

It is difficult for the colleagues and friends in the Laboratory of Colloid Science, and others who have been intimately connected with John Keith Roberts, to realize that he has departed from us. He died on April 25, aged forty-seven.

I first met 'J. K.' when he was working in the Cavendish Laboratory. At that time, under the genial guidance of Lord Rutherford, the main interest in the Cavendish lay in the problems of nuclear structure. To 'J. K.', however, the nucleus had no attraction; he was both by training and inclination steeped in the classical tradition of physics based upon thermodynamics. He was at the time engaged upon the problem of the extent to which thermal energy is exchanged when gas molecules hit and leave a solid surface. He found that the values for the accommodation coefficient were coming out unexpectedly higher than anticipated from Baule's calculations. In my Department we were searching for different methods by which layers of gas adsorbed at metal surfaces could be detected and examined, and it seemed possible that the high values for the accommodation coefficient which Roberts found were due to the presence of a chemisorbed layer of gas on the tungsten wire which he was using. If this proved to be the case, the accommodation coefficient might serve as a useful tool for exploring surfaces.

Roberts welcomed with enthusiasm the suggestion of moving from the Cavendish to next door, and taking up this field of inquiry. He devoted the next ten years of his life to this problem. In this investigation he was strikingly successful. Roberts not only showed how one could trace and follow the building up of adsorbed monolayers on tungsten wires by means of the accommodation coefficient of neon as an indicator, but also later developed methods for actually measuring the heat of adsorption of gases on thin wires by making the wire one arm of a Wheatstone bridge. A series of papers both experimental and theoretical testify to the great skill, painstaking accuracy, and attention to detail which characterized all his work. Methods had to be worked out for circulating pure neon over scrupulously clean wires and for the admission of gases at minute but regulated pressures. The apparatus was essentially simple, but the elimination of contamination in the system indicates the extraordinary cleanliness which he achieved. Many important discoveries were made, and what had hitherto been matters of opinion experimentally tested. Thus it was found that when the tungsten wire was clean, chemisorption of several elementary gases occurred without appreciable energies of activation, that a slow process of activated diffusion could take place into the wire, and that gases could be quantitatively displaced from the surface. When diatomic gases were chemisorbed as atoms, holes were left in the surface which play an important part when chemical reactions take place in the adsorbed phase. He showed that there could be a transition from immobile to mobile monolayers, and revealed how the influence of mutual interaction between the adsorbed particles could be traced both in the form of the adsorption isotherm and in the thermal behaviour on adsorption.

Apart from this field of inquiry, which he made particularly his own, Roberts took a great interest in many other problems, especially in the mechanism of melting of a crystalline solid and in the origin of the elasticity in rubber. He was always ready to give his advice and criticism to those commencing research. Here, for Roberts, no trouble was too great, no time too long. Many have gained from the lasting impression he made by his directness and simplicity of approach in experimental attack, his insistence upon rigour in argument and soundness in thermodynamic treatment. His lectures were clear and attractive, and his book on thermodynamics has already gone into the third edition. Little can be said at present about his activities in the War, but he took a post in a naval research establishment that was difficult administratively, and involved research and development along important and novel lines. Here he was an unqualified success.

In the laboratory Roberts was always cheerful and ready to deal with all the vexatious details which arise—this in spite of his health, which was never good. At times a leg gave him much trouble, but no one ever heard a word of complaint. He took much pleasure in the fact that his work was appreciated, both at home and abroad. He had been elected to the fellowship of the Royal Society and quite recently made a fellow of Christ's College, and was looking forward to his return to Cambridge, where his heart lay.

Eric K. Rideal.

We regret to announce the following deaths:

Dr. J. A. Campbell, of the research staff of the National Institute of Medical Research, on April 20, aged sixty.

Lieut.-Colonel Stanley Casson, reader in classical archæology in the University of Oxford, aged fifty-four.

Mr. H. B. Walters, O.B.E., keeper of Greek and Roman antiquities in the British Museum during 1925–32, on April 24, aged seventy-seven.

NEWS and VIEWS

Botany in the University of London

King's College

PROF. T. A. BENNET-CLARK, of University College, Nottingham, has been appointed to the University of London chair of botany, tenable at King's College, London, as from October 1944. Prof. Bennet-Clark was educated at Marlborough College and Trinity College, Cambridge, and in 1923 was placed in the first class of the Natural Sciences Tripos (Part II) list and was the Frank Smart Prizeman. He worked for a time under Dr. F. F. Blackman until, in 1924, he was appointed as assistant to the professor of botany, Trinity College, Dublin. During these years, research on the metabolism (especially the respiration) of succulent plants yielded results of great interest. This line of research continued after his appointment in 1931 as lecturer in botany in the Victoria University of Manchester. His appointment to Manchester coincided with an increase in the number of research students there, and a large proportion were then attached to plant physiology and under his guidance investigated the metabolism, especially of acid-producing plants, including fungi, while research on another aspect of plant physiology served to focus attention on the important part which protoplasmic activity may play in water absorption by plant cells. Under his direction plant physiology at Manchester received a considerable stimulus. In 1936 he was appointed to the chair of botany at University College, Nottingham, where a heavy burden of teaching has not restricted his other activities. Since 1937 he has served the Society of Experimental Biology as botanical secretary. Botanists throughout the country will wish him success and happiness in his new appointment.

Birkbeck College

BY the appointment of Dr. C. T. Ingold to the chair of botany, Birkbeck College maintains a strong mycological tradition built up during the period of office of Dame Helen Gwynne-Vaughan. Dr. Ingold is well known for his studies on the aquatic Hyphomycetes, and for work on mechanisms of spore dispersal in fungi. He is a keen and first-class naturalist, and one of the limited band of those who 'know their higher Basidiomycetes', so that it is a real pleasure to tramp the country with him as guide. He conveys his enthusiasm with success to students and colleagues. Dr. Ingold was a student of the Queen's University, Belfast, and has served on the staff of the University of Reading. Latterly he has been head of the Department of Botany at University College, Leicester. His published work includes papers on permeability, aquatic fungi and algæ, and an attractive book on spore dispersal.

Transmutation of Wood

IN a short message printed in *The Times* of April 17, attention is directed to what is claimed to be a new chemical treatment which makes wood nearly as hard as steel, transmuting it into a new material, part wood and part plastic, announced by the du Pont Company in the United States. From the brief description given, it appears that this new material is only one of the many forms of what has become known as 'improved wood'. Until specimens have been examined it is not possible to verify the claims. In preparing a material of this kind it is, in general, sought to improve the strength properties and the dimensional stability of wood by a combination of impregnation with synthetic resins and densification under heat and pressure. The manner of effecting this varies from process to process. It was believed for some years that the use of synthetic resins was essential for the production of improved wood, but only recently the U.S. Forest Products Laboratory has demonstrated that much of what is done by the earlier processes can be achieved through the use of heat and pressure alone.

In the use of synthetic resins for making 'improved wood', most success has been achieved with the phenol-formaldehyde type. Hitherto the amino resins have not been favoured for the manufacture of improved wood, presumably because they have been found to be chemically not so stable as some other types and to have somewhat inferior ageing characteristics under warm and humid weather conditions. It remains to be seen, therefore, whether the urea/formaldehyde resin involved in the Dupont process incorporates any new feature which marks it out as superior to others of its class. It is stated that the monomer combines with the natural acids in the wood; but the more conventional view of the setting process would appear to be that these acids merely behave like all other acids which are known to catalyse the setting reactions in urea/formaldehyde resins. The two claims which it will be most interesting to confirm are that almost any species of timber can be treated—particularly as nothing is said as to the thickness of piece which can be treated—and that all dimensional change is prevented. So far as existing experience goes, this latter claim seems to be incompatible with the implied retention of the best other properties of wood. Should these claims hold good after a period of years, the process will mark a big advance in the field of wood-plastic composites.

Development of the Highlands of Scotland

A CRITICAL study in the February number of *Agenda* by Mr. Hugh Quigley on "The Highlands of Scotland: Proposals for Development", urges that the one policy which will make a permanent contribution to the Highland civilization is in effect to make a collective regional unit of the Highlands after the pattern of the Tennessee Valley Authority. Mr. Quigley strongly criticizes the creation of the North of Scotland Hydro-Electric Board, which has only indirect influence on the problem of Highland reconstruction; it regularizes the supply of electricity, but electricity has not been, and is not, the sole essential for new developments. The lack of industrial enterprise is not to be attributed to any defect in availability or price of electricity. The economic condition of the Highlands has not changed materially since the Hilliary Committee reported in 1938. The War, if anything, has caused further deterioration through cutting of timber, much of it immature, and restriction of communications, but has, on the other hand, brought greater activity to the ports. Reconstruction cannot be carried out piecemeal but must cover as wide a range of economic factors as the state of our knowledge and the limits of administrative ability will permit.

Reconstruction in the Highlands should be entrusted to a Highland planning authority with powers similar to those of the Tennessee Valley Authority and over-riding control over the North of Scotland

Hydro-Electric Board. The activities of the Forestry Commission should be wound up so far as they apply to the Highlands of Scotland, and its functions transferred to a Scottish national parks section of the planning authority. The Scottish Department of Agriculture should cease to own and administer land and its holdings transferred to the planning authority. The Planning Section of the Scottish Department of Health should be considerably extended and its functions widened to cover supervision of development schemes proposed by the planning authority, and, until the latter is formed, of the North of Scotland Hydro-Electric Board. Reform and re-alignment of Highland local authorities must accompany or result from the creation of a planning authority: in their present form they are incapable of contributing usefully to any fundamental scheme of economic reconstruction.

Patent Law Reform

A COMMITTEE has been appointed to consider and report whether any, and if so what, changes are desirable in the Patents and Designs Acts, and in the practice of the Patent Office and the Courts in relation to matters arising therefrom. In particular, the committee is to consider the conduct of legal proceedings arising out of the Patents and Designs Acts, including the constitution of the appropriate tribunals; and, in connexion with the prevention of the abuse of monopoly rights, it will suggest amendments to facilitate settlement and the reduction of the cost of legal proceedings and encourage the use of inventions and the progress of industry and trade.

The committee is constituted as follows: Mr. Kenneth Swan, K.C. (*chairman*), Mr. Hubert Gill, Mr. James Mould, Captain B. H. Peter, Dr. D. R. Pye, Mrs. Joan Robinson, Mr. H. L. Saunders and Dr. A. J. V. Underwood.

Trade Unions in Great Britain

MRS. MARY AGNES HAMILTON's pamphlet "British Trade Unions" (Oxford Pamphlets on Home Affairs, No. H.47. Oxford University Press. 6*d*. net), which gives a brief survey of trade union history in Britain, is of particular interest for its description of the position of the trade unions in relation to the State and to society in Britain to-day. While the value of the trade union as a training ground for democracy is well brought out, and also its dependence upon democracy as a condition of effective functioning, neither the essential strength ncr the weakness of trade unionism is indicated so clearly as might be expected. Mrs. Hamilton quotes Mr. Bevin's enunciation of the central idea "the liberty of the ordinary man and the right relationship between fellowmen" which is also the central idea of democracy; but she fails to point out that the co-operation and collective bargaining represented by the trade unions is indispensable in the industrial and economic conditions of to-day. Without them our war effort could not easily have attained its present pitch, nor could many advances in welfare and the like have been so readily achieved. Equally she overlooks the innate conservatism of the trade unions, which is the real weakness that has hindered their making their full contribution to the development of democratic ideas and practice and to social and economic progress—a weakness as marked in the newer unions of technical and professional workers as among the older unions of manual workers in its customary sense.

Institute of Metals

IN his presidential address to the Institute of Metals on March 15, the new president, Dr. W. T. Griffiths, devoted much of his attention to the widefelt need for a greatly increased number of trained metallurgists in industry. Apart from stressing the demands to be made on institutions of university standing, he mentioned the probability that, in conjunction with other metallurgical bodies and the Board of Education, there is the probability of the immediate institution of National Certificates in Metallurgy similar to those already existing for engineering. This movement received both his own welcome and that of the Council of the Institute. The demand for the greater recognition of the profession of the metallurgist is under consideration by all three metallurgical institutions, and the probability was mentioned that some qualifying board, independent of, but working in co-operation with those bodies, would soon be set up. The desirability of co-operation between the Institute of Metals and the Iron and Steel Institute, already close, becoming still more intimate, a development to be welcomed on many grounds, was stressed, and the announcement that Mr. Headlam-Morley, the secretary of the Iron and Steel Institute, is to act, for the time being, as secretary of the Institute of Metals in succession to Mr. Shaw-Scott, is a clear indication of such an increasing unity of purpose.

The Institute of Metals Medal for 1944 was awarded to Lieut.-Colonel the Hon. R. M. Preston, president during 1940–42 of the Institute.

The Golgi Apparatus

IN his presidential address to the Section of Zoology and Entomology of the thirty-first Indian Science Congress at Delhi, Prof. Vishwa Nath gave a general account of his own views on the nature of the Golgi element. He regards Golgi nets, dictyosomes, batonettes, rods and crescents as optical illusions, and one appearance only as genuine—that of a spherical osmiophil and argentophil cortex enclosing a spherical chromophobe core. These plainly correspond with the externum and internum of Hirsch, and although Prof. Nath is strongly opposed to the vacuome theory of Parat, yet it seems likely that the chromophobe cores correspond with Parat's vacuoles. He opposes strongly the opinion that the Golgi element is concerned with cellular secretion, and argues that, on the contrary, it is transformed into such objects as others think it secretes. He is concerned to show that in forming the acrosome, the Golgi element is completely used up, a conclusion with which many students of this cell inclusion will find themselves in disagreement. It seems possible that the difference between secretion and transformation may to some extent be a verbal one, scarcely calling for the expression of such strong opinions as those of Prof. Nath. The greater part of the address was very clearly worded. Students of the Golgi element find themselves in disagreement on several matters, and it is helpful to all concerned when views are unequivocally expressed.

Nutrition Problems in Venezuela

THE August issue of the *Boletín de la Oficina Sanitaria Panamericana* contains a note on this subject, which was discussed at the eleventh Panamerican Sanitary Congress at Rio de Janeiro in

1942. As regards nutrition in Venezuela, the same conditions exist as in the other Caribbean Republics, and in some respects as in those in the other Latin American republics. All the publications on the subject come to the same conclusion, namely, that the labouring class is inadequately fed and consumes excessive amounts of carbohydrates compared with other elements such as proteins, vitamins, etc. In many cases a family has to spend 75 per cent of its income on food alone. Farm workers, on the other hand, though receiving much lower salaries, spend less on their food, or 47 per cent of their income, which adequately provides for their food. This situation would be much improved by an educational campaign.

Earthquakes Recorded at Kew

DURING the period December 1, 1943–February 1, 1944, eight strong earthquakes were registered at Kew. Of these, three were in December, four in January and one on February 1. Two earthquakes were registered on December 1, the first being at 06h. 18m. 50s. G.M.T. from an epicentre tentatively calculated to have been 14,600 km. distant. The maximum amplitude attained at Kew was 26 μ. The second on December 1 was registered at Kew at 10h. 47m. 59s. G.M.T., and this also attained a ground amplitude at Kew of 26 μ. Its epicentre has been calculated by the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association to have been at lat. 20·2° S., long. 68·1° W., which is in south-west Bolivia. Its depth of focus was probably near 100 km. On December 23 an earthquake was registered at Kew at 19h. 21m. 32s. G.M.T. and attained a maximum amplitude at Kew of 115 μ. Its epicentral position has been calculated by the United States Coast and Geodetic Survey to have been near lat. 6° S., long. 152° E., which is east of New Guinea. Other earthquakes occurred on January 5 (two), 10, and 16. The earthquake on February 1 registered at Kew at 03h. 27m. 59s. G.M.T., had a maximum ground amplitude at Kew of 1,000 μ; it has already been mentioned in the columns of NATURE as having occurred in Turkey.

Two earthquakes not apparently registered at Kew in any strength occurred on December 21, at 13h. 46·4m. G.M.T., from an epicentre near lat. 13° N., long. 70·5° W., and on December 23 at 15h. 56·0m. G.M.T. from an epicentre near lat. 13·3° N., long. 70·4° W. Both are in the Gulf of Venezuela. These shocks were registered at Tucson, St. Louis, Spring Hill, Georgetown, San Juan, Philadelphia, Burlington, Lincoln, Fordham, Pasadena, Huancayo and Chicago, and their provisional epicentres were calculated by the United States Coast and Geodetic Survey in co-operation with Science Service and the Jesuit Seismological Association.

Prof. Alexander Macalister, F.R.S. (1844–1919)

PROF. ALEXANDER MACALISTER, the famous Cambridge anatomist, was born on April 9, 1844, in Dublin, where he was educated at Trinity College. He qualified at the Irish Royal Colleges in 1861, became M.B. at Trinity College ten years later and M.D. in 1876. After acting as demonstrator of anatomy at the Royal College of Surgeons in Ireland, he was appointed professor of zoology, and eight years later professor of anatomy and chirurgery, at Dublin. In 1883 he succeeded Sir George Murray Humphry in the chair of anatomy at Cambridge, and held this post for thirty-six years. He was a prolific writer. Besides his "Text-book of Human Anatomy" (1889) for which he is best known, he was the author of "Introduction to Animal Morphology" (1876) and "Morphology of Vertebrate Animals" (1878) as well as of numerous papers on animal morphology, human anatomy and small text-books for students. He was a man of remarkable versatility, being an able mathematician as well as versed in archæology, Egyptology and draughtsmanship. Like his cousin, Sir Donald Macalister, he was a proficient linguist, having knowledge of fourteen languages. He received many honours. In 1881 he was elected a fellow of the Royal Society. He was made hon. LL.D. of the Universities of Edinburgh, Glasgow and McGill and hon. D.Sc. and senator of the University of Dublin. His name has been attached to the fovea gastrica and the annulus femoralis s. cruralis.

Announcements

ON the joint recommendation of the presidents of the Royal Society and the Institution of Civil Engineers, the Council of the Institution of Civil Engineers has awarded the James Alfred Ewing Medal for 1943 to Group Captain Frank Whittle. The Ewing Medal is awarded annually for specially meritorious contributions to the science of engineering in the field of research.

AT the ninety-seventh annual general meeting of the Palæontographical Society held in the rooms of the Geological Society at Burlington House on April 26, with the president, Prof. H. L. Hawkins, in the chair, it was resolved that the Society's Council be empowered to take such steps as be necessary to mark the approaching centenary of the Society in 1947. A committee has therefore been formed to consider suggestions as to how the occasion should best be commemorated; the secretary is Dr. C. J. Stubblefield, H.M. Geological Survey and Museum, London, S.W.7.

ACCORDING to the *Lancet* of April 8, Brigadier-General Leon A. Fox, director of the United States Typhus Commission, says that more than 1,800,000 c.c. of typhus vaccine supplied to Governments in the Middle East under Lend Lease since last June now are a gift of the United States Government. The Typhus Commission has instructions to make the vaccine available to public authorities wherever typhus epidemics appear. Shipments have gone to Egypt, Persia, Iraq, Cyrenaica, Eritrea, Palestine, Trans-Jordan, Tripolitania, Saudi Arabia and Aden.

IN the course of a review published in NATURE of February 19, p. 207, it was stated that the American Philosophical Society became a local scientific association for Philadelphia after the American Association for the Advancement of Science was formed. This is incorrect. The members of the Society come from all parts of the United States and there are at least fifty foreign members. It holds three general meetings a year, which are attended by members and others from all parts of the country, and is generally recognized as the most distinguished organization in America dealing with all fields of learning.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Radioactivity and the Origin of Life in Milne's Cosmology

ACCORDING to the cosmological theory of Milne, we may either describe events in terms of a time t with a finite past, and Euclidean space, or of a time $\tau = t_0 + t_0 \log \frac{t}{t_0}$, where t_0 is the present epoch on the t-scale, and hyperbolic space. On the t-scale the radius of the material universe is ct, the spiral nebulæ are receding, and the lengths of rigid objects are proportional to t, but spectral frequencies are constant. On the τ-scale the nebulæ are not receding, nor is matter expanding, but spectral frequencies are proportional to t at the instant of emission, the light from distant nebulæ being red because it was emitted long ago. The two descriptions of the universe lead to the same predictions regarding all observable events.

It seems worth pointing out some consequences of this theory for geology and biology. The results of these sciences are most naturally expressed in the τ-scale and hyperbolic geometry. For on the t-scale the year and day are a good deal longer than they were in palæozoic times, and a dinosaur's bones are larger now than they were in life. On the other hand, on the τ-scale the amount of energy needed to raise a given object through a given distance is invariant with time, and mechanics are very nearly Newtonian. The heat conductivity of a gas at least, and probably of a solid, is invariant. On the other hand, the rate at which energy is liberated by subatomic or chemical change is constant on the t-scale, but increases on the τ-scale.

This is readily seen in the case of radioactivity. The decay 'constant' is only constant on the t-scale. Thus of N_0 radioactive nuclei present when $t = 0$, $N = N_0 e^{-\lambda t}$ survive to time t. The radioactivity of a given mineral sample, measured by the number of transformations per sidereal year, is

$$-\frac{dN}{d\tau} = \lambda N_0 \frac{t}{t_0} e^{-\lambda t}.$$

So the 'constant' on the τ-scale varies with t. Thus the 'years' of the geological time-scale based on radioactivity are not sidereal years on Milne's theory. Taking $t_0 = 2 \times 10^9$, the earth has gone round the sun $5{\cdot}55 \times 10^8$ times since a rock of radioactive age 5×10^8 'years' was formed, and $2{\cdot}77 \times 10^9$ times since a rock of age $1{\cdot}5 \times 10^9$ 'years' was formed.

The radioactivity $-\frac{dN}{d\tau}$ of a given piece of rock reaches a maximum when $\lambda t_0 e^{\tau/t_0 - 1} = \lambda t = 1$. Thus for ^{238}U, with $\lambda = 1{\cdot}5 \times 10^{-10}$ (year^{-1}), the maximum will occur at $t = 6{\cdot}75 \times 10^9$, or about A.D. $4{\cdot}3 \times 10^9$ on the τ-scale, when it will be about $2{\cdot}4$ times as active as to-day, though containing less uranium. The radioactivity of rocks containing potassium will increase for a vastly longer period; and still later, elements now regarded as stable may show an activity appreciable on the τ-scale, and having appreciable thermal effects if conductivity is constant. Of course, these arguments would still hold if the nuclei in question were formed after $t = 0$, $\tau = -\infty$. These considerations have a considerable bearing on the thermal history and future of the earth. The possibility that similar considerations apply to the stars should make us sceptical of certain extrapolations into the remote past and future.

Consider a living organism at a time in the past when t was comparatively small. It had to do work of various kinds. The measure of most types of work on the τ-scale is independent of t. But the amount of energy available from a chemical reaction such as an oxidation, or the breakdown of adenosine-triphosphoric acid, the immediate source of muscular energy, was not constant. Presumably the energy yield of a given molecular transformation varies with t like that of a given atomic transformation. Thus, in the past, chemical change was less efficient as a source of mechanical energy than it is to-day. Further, the rate of unimolecular breakdown of an enzyme-substrate compound such as myosin-adenosine-triphosphoric acid is sometimes at least the limiting factor in biochemical reactions liberating free energy. If the unimolecular 'constant' is k on the t-scale, it is $\frac{kt}{t_0}$ on the τ-scale, as with the 'constant' of radioactive decay. Thus the actual rate of energy liberation may be expected to vary as t^2.

If so, at a sufficiently early stage, a living organism would have been unable to provide even the small energy needed for cell division or amœboid movements. At a later time, life of a simple sort would have been possible, but locomotion would have been very difficult, and large swimming or crawling animals could not have existed.

Thus on Milne's theory we should expect, first, that life could not originate until a considerable fraction of time on the t-scale, and therefore almost all eternity on the τ-scale, was past, and secondly, that large and fairly complex motile animals should not have originated until a much more recent date. For even when $t = \frac{t_0}{\sqrt{2}}$, or $\tau = 690{,}000{,}000$ B.C. (late Pre-Cambrian), energy for motion would only have been generated at half its present rate. Further, in the remote future, even if the universe degenerates towards thermal equilibrium, or cold matter plus low-frequency radiation, the mechanical efficiency of chemical processes may so increase that life is still possible.

More or less analogous, though sometimes opposite, conclusions follow from other theories, such as those of Eddington and Dirac, in which the fundamental parameters of physics vary with time. These theories are at least possibly true, and biologists who are interested in the remote past and future of life should be aware of their possible implications.

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Nature of the Cation Exchanges during Short-Period Yeast Fermentation

DURING the fermentation of glucose by yeast, Pulver and Verzar[1] showed that potassium was absorbed from the external fluid and released again towards the end of fermentation. Leibowitz and Kupermintz[2] showed a similar occurrence in bacteria (*B. coli*). These workers believed the potassium changes to be

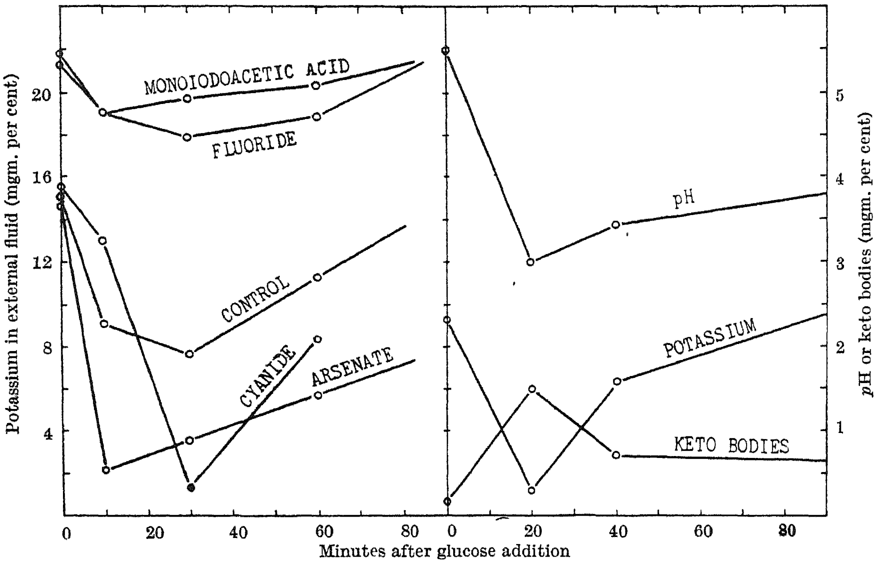

FIG. 1a. 1 VOL. YEAST, 3 VOL. $M/200$ KH_2PO_4 CONTAINING INHIBITORS IN $M/200$ STRENGTH, MIXTURE ALLOWED TO STAND FOR 30 MIN. AND 0·15 VOL. OF 18 PER CENT GLUCOSE ADDED. FIG. 1b. SAME MIXTURE WITHOUT INHIBITORS.

specific for this ion, but it was shown by us[3] that 'ammonia' yeast in which all the potassium of the cells was replaced by NH_4^+ behaved in a similar way with respect to the NH_4^+ ion. An explanation of the process was advanced in which it was considered that potassium entered with phosphate and, this being esterified, held the potassium inside electrostatically, more potassium entering then to equalize the products of potassium and phosphate ion concentrations without and within. Towards the end of fermentation, this process was presumably reversed, and so accounted for the potassium or ammonium released.

Subsequent investigations here have shown that such an explanation accounts only for a small part of the potassium absorption, and the phosphate that entered did not return like the cations to the external fluid. The fuller explanation would seem as follows. The cations which enter the cell during fermentation appear to do so very largely in exchange for hydrogen ions formed by the dissociation of pyruvic acid (or phosphopyruvic acid) formed towards the outer edge of the cell.

The evidence on which this is based is briefly as follows:

(*a*) The change of hydrogen ion concentration in the external fluid synchronizes fully with the potassium ion change (as shown in Fig. 1*b*), and the titration of the external fluid back to the original hydrogen ion concentration more than accounts for the potassium absorbed.

(*b*) The liberation of the hydrogen ion is due to pyruvic acid formation, since inhibitors which prevent its formation, for example, fluoride and monoiodoacetic acid, greatly depress the potassium absorption or the hydrogen ion formation (Fig. 1*a*), and monoiodoacetic acid more than fluoride. Also the analysis of the yeast and of the external fluid shows changes in keto acid formation which are likewise synchronous with the potassium and hydrogen ion changes.

(*c*) The interchange of potassium and hydrogen ions as a movement towards equilibrium is supported by the fact that if no potassium is present outside before fermentation, comparatively large amounts come out when glucose is added, thus reversing the direction of the potassium passage. Also, if the external potassium is raised and the solution outside the yeast cells be maintained as unbuffered as possible (using only potassium chloride and well-washed yeast) the hydrogen ion increases parallel with the potassium increase, and reaches very high levels. On the other hand, if the pH be maintained at 2–5 with comparatively low potassium outside, the proportion of potassium absorbed increases with increasing pH. Such experiments are in strong support of the view that the potassium and hydrogen ions are interchanging as a movement towards some point of equilibrium (or steady state, the movement in itself being conditioned by a fall of free energy).

(*d*) The ratio of the potassium and hydrogen ion concentrations outside is at the same time quite different from the ratio in the yeast cell as a whole, so that the hydrogen ion production would seem to be confined to some part of the yeast cell. When yeast, for example, is first pressed to get rid of as much external fluid as possible, frozen in liquid air, and then thawed so as to release the internal fluid of the cells, this latter has a pH of approximately 5·8. This pH does not decrease if the fluid is extracted from the fermenting yeast cells. It shows rather a slight increase.

(*e*) Supporting evidence for spaces in yeast with different permeabilities is given by the time curve of entrance of urea, and also of ammonia (with carbon-dioxide bubbling as in making the 'ammonia' yeast). Distinct breaks on these curves appear, presumably indicating zones with different permeabilities.

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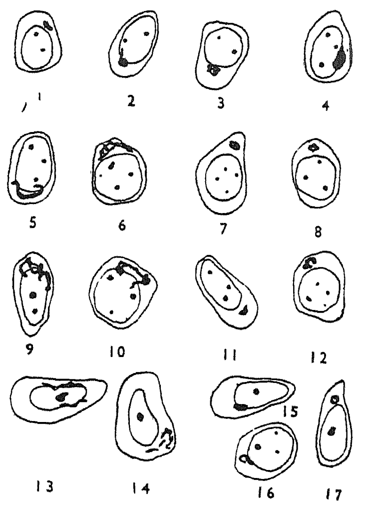
March 16.

[1] Pulver, R., and Verzar, F., *Helv. Chim. Acta*, **23**, 1087 (1940).
[2] Leibowitz, J., and Kupermintz, N., NATURE, **150**, 233 (1942).
[3] Conway, E. J., and O'Malley, E., NATURE, **151**, 252 (1943).

Effect of Colchicine on Golgi Bodies

DURING the course of an investigation on the mitotic activity of the mouse parathyroid gland at different ages[1], using the colchicine technique, very marked alterations in the morphology of the Golgi bodies were observed in material prepared by the Nassonov-Kolachev method. Since the initial observations were made on immature animals, the glands of adult colchicine-injected mice were also investigated.

The results of these experiments are shown in the



1 and 2, cells from 2 days ♀ parathyroid, untreated; 3 and 4, cells from 2 days ♂ parathyroid, untreated; 5 and 6, cells from 12 days ♀ parathyroid, untreated; 7 and 8, cells from 12 days ♀ parathyroid, 0·02 mgm. colchicine for 9½ hr.; 9 and 10, cells from 20 days ♀ parathyroid, untreated; 11 and 12, cells from 20 days ♂ parathyroid, 0·03 mgm. colchicine for 9½ hr.; 13 and 14, cells from adult ♂ parathyroid, untreated; 15 and 16, cells from adult ♂ parathyroid, 0·1 mgm. colchicine for 22 hr.; 17, cell from adult ♂ parathyroid, 0·1 mgm. colchicine for 3 hr.

accompanying illustration. In the case of the adult animals 0·1 mgm. of colchicine was given subcutaneously and the animals were killed at varying intervals after the injection. Immature animals were given a dose in proportion to their body weights and were killed after 9½ hours.

It will be seen from the figures that both the reticulate Golgi bodies of the juvenile gland (Figs. 5, 6, 9 and 10) and the more dispersed and thread-like Golgi material of the adult (Figs. 13 and 14) are affected in the same manner. The effect is particularly striking in the adult gland, where the cells have very varied Golgi-body configurations, probably associated with different states of cellular activity[2,3]. In these instances there is a reduction in size and a marked condensation of the Golgi substance into one and sometimes more granular structures, which frequently assume a ring-like form (Figs. 8, 16 and 17). In one instance (Fig. 17), a marked effect was observed so soon as three hours after injection. This reduction in size and dispersion of the Golgi bodies tends towards a morphological resemblance with those of very young mice (Figs. 1–4).

The effect of colchicine on the mitochondria of parathyroid cells was not so striking, because changes in the extremely small granular mitochondria were not immediately obvious. Most of them, however, were spherical in shape, indicating a marked reduction in the proportion of the rod-like forms normally to be seen in untreated animals. In four instances the duodenum of injected animals was examined and it was found that both the proximal and distal mitochondria of the epithelial cells of the villi were spherical in form; the thread-like type to be found on the distal side of the nucleus was not observed.

It is well known that many substances influence the form of the Golgi material in cells. There are the naturally occurring œstrogenic substances acting upon the cells of the anterior lobe of the pituitary[4] and the uterine mucosa[5]; toxic substances produced in pathological conditions acting on a great variety of cells; and substances foreign to animal tissues such as morphine, which itself has a marked effect on the Golgi bodies of the spinal neurones of rats[6]. In all these instances, above a certain threshold value, the effect consists in hypertrophy of the Golgi element commonly followed by fragmentation. By contrast, the effect of colchicine on the parathyroid is to cause a reduction in the degree of dispersion of the Golgi material, an effect somewhat similar to that produced by the injection of the parathormone itself[7].

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March 20.

[1] Foster, C. L., Nature, 151, 277 (1943).
[2] Foster, C. L., *J. Endocrinol.*, 3, 244 (1943).
[3] De Robertis, E., *Revista Medica Latino-Americana*, No. 323 (1942).
[4] Severinghaus, A. E., in "Sex and Internal Secretions", edited by Allen, E. (1939).
[5] Horning, E. S., *J. Endocrinol.*, 3, 260 (1943).
[6] Horning, E. S., in "Cytology and Cell Physiology", edited by Bourne, G., 131 (1942).
[7] De Robertis, E, *Anat. Rec.*, 78, 473 (1940).

Plasma Cholinesterase in Male and Female Rats

Beveridge and Lucas[1] found that the serum cholinesterase activity of mature female rats was three to five times greater than that of mature males or immature females. Similar differences in the cholinesterase activity of rat liver due to sex were also reported by Zeller and co-workers[2]. These reports were made before Mendel and Rudney[3] had established that there are two cholinesterases in the body—one a specific or true cholinesterase, exerting its maximum activity at low concentrations of acetylcholine (about 3 mgm. per cent), and the other a non-specific or pseudo-cholinesterase, capable of hydrolysing other esters besides those of choline and having its maximum effect at high concentrations of acetylcholine (above 300 mgm. per cent). Beveridge and Lucas[1] and Zeller[2] had estimated rat cholinesterase at high concentrations of acetylcholine which would mask the activity of the specific enzyme and thus represent mainly the activity of the pseudo-cholinesterase.

Recently, acetyl-β-methylcholine and benzoylcholine, specific substrates[4] for true and pseudo-cholinesterase respectively, were used to determine the activities of these two enzymes in the plasma of albino rats, and the values obtained were compared with the activity of the plasma towards acetylcholine. Average results for three groups of rats, mature females, mature males and immature females, are shown in the accompanying table.

In agreement with the results of Beveridge and Lucas, it is seen that the activity towards acetyl-

Cholinesterase activity of rat plasma.

	No. of animals	μl. CO_2 evolved by 1 ml. plasma in 20 min.		
		Acetylcholine (0·06 *M*)	Benzoylcholine (0·006 *M*)	Acetyl-β-methylcholine (0·03 *M*)
Mature females	12	606·8 ± 203	128·6 ± 49	62·0 ± 8·3
Mature males	13	170·5 ± 25·4	30·4 ± 9·7	51·7 ± 10
Immature females	20	155·8 ± 29·5	30·5 ± 4·9	43·7 ± 8·1

choline is three–four times higher in the mature females than in the other two groups. The activity towards benzoylcholine, being about four times greater in the plasma of the mature females, parallels the activity towards acetylcholine and shows that the higher activity is due mainly to the pseudo-cholinesterase. Although the differences between the groups in their activities towards acetyl-β-methylcholine are significant statistically, the true cholinesterase certainly would not account for the much higher values found in the plasma of mature females at high concentrations of acetylcholine, since this enzyme contributes little to the activity at these substrate concentrations.

Thus the greater activity of the plasma of mature female rats towards acetylcholine, as compared with that of mature males and immature females, is due mainly to the activity of the pseudo-cholinesterase.

I acknowledge the assistance of a grant from the Banting Research Foundation.

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March 16.

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[2] Zeller, E. A., and Birkhauser, H., *Helv. Chim. Acta*, **24**, 120 (1941).
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Prenatal Mortality

In the interesting article[1] on "Prenatal Mortality and the Birth-Rate", Dr. A. S. Parkes states, "The amount of prenatal mortality from the time of conception to the time of birth is known to be considerable in many mammals, figures so high as 40 per cent or more having been determined". At least in one mammal, the wild rabbit, a much higher mortality has been recorded, and investigation has shown that with the technique normally employed the full extent of mortality may be overlooked.

It was estimated in a recent paper[2] that the prenatal mortality in wild rabbits in Caernarvonshire in 1941 was not less than 45–58 per cent. More recently[3], with much more extensive supplementary data obtained in 1942, it has been shown that the prenatal mortality approximated to 64 per cent. Of this enormous mortality, 60 per cent is accounted for by the total loss of whole litters about the twelfth day of gestation. The remaining 4 per cent represents a sporadic loss of approximately 10 per cent of the ova in the surviving litters. Further work in progress is designed to show whether this mortality is general in other areas.

The prenatal mortality in polytocous animals is estimated normally by comparing the number of corpora lutea in the ovaries with the number of macroscopically visible embryos in the uterus. This is possible because, as a rule, embryos that die are reabsorbed *in situ*, without disturbing the course of gestation of the remaining embryos. Abortion is a common sequel to embryonic death in monotocous animals, but in polytocous animals it occurs rarely, unless the embryos die near full term. However, if all the embryos in a polytocous animal die almost simultaneously and are reabsorbed *in situ*, the effect on the estimate is much the same as if they were aborted, for once the re-absorption is complete, the mother, being no longer pregnant, would not be included in the sample on which the estimate is based. Hence litters lost in this way would be included in the estimate only if the embryos were actually in process of re-absorption at the time of examination. Consequently, estimates of prenatal mortality, based on counts of corpora lutea and embryos in samples including all visible stages of pregnancy, are liable to be extremely misleading. For example, such an estimate, from the rabbit data referred to, would disclose a mortality of only 24 per cent.

The loss of whole litters in this way can be detected and estimated by dividing the data, according to the stage of development of the embryos, into groups, each of which covers a period nearly commensurate with the time required for the complete re-absorption of a dead embryo of that stage, and by estimating the mortality in each group separately. Clearly, if a significantly higher mortality is found in any of the earlier groups than in the later groups, it can be accounted for only by postulating the loss of whole litters and their disappearance from the samples comprising the later groups; because the corpora lutea persist throughout gestation, and the discrepancy between the number of them and of embryos represents the whole of the loss of ova in that animal from the time of ovulation.

Unfortunately, this method of fractionation requires extensive data and is laborious; but it is clear that until the method has been applied to polytocous mammals, other than the rabbit, it is unsafe to conclude that prenatal mortality in them does not exceed existing estimates and that the loss of whole litters is not of more frequent occurrence than has been supposed hitherto.

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Ivor H. Mills.

Department of Zoology,
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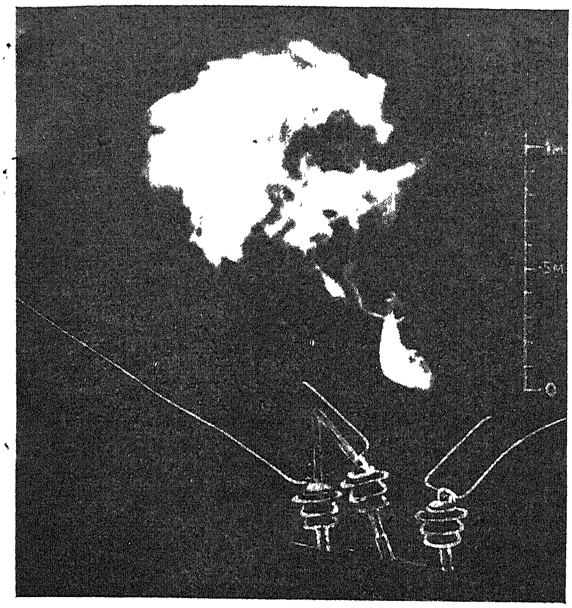
March 22.

[1] Parkes, A. S., Nature, **153**, 245 (1944).
[2] Brambell, F. W. Rogers, *Proc. Roy. Soc.*, B, **130**, 462 (1942).
[3] Brambell, F. W. Rogers, *Proc. Zool. Soc. Lond.* (in the Press).

Diffusion Phenomena in Alternating Current Arcs

The successful interruption of large currents at high voltages has been the subject of considerable research, the general aim being to bring about a low-energy release in the circuit breaker by having a short arcing period. During recent years, attention has been focused on the use of a high-velocity blast of gas to effect consistently rapid interruption and at the same time avoid setting up destructive voltage surges in the circuit. Numerous oscillograms have shown that final interruption takes place towards the end of a half-cycle, and for this reason great interest has been taken in the de-ionizing influences which are active immediately after current zero.

While it is generally agreed that diffusion enhances the recovery of dielectric strength during at least the first 10 microseconds after the recorded current zero, there are differences of opinion as to the mechanism which is mainly responsible for avoiding the re-striking of the arc. By suitable mechanical arrangements[1], a gas blast can be so directed that some time after current zero a wedge of cold gas is inserted in the arc trace. This wedge extends rapidly and can



EXTINCTION OF 10 KV., 280 AMP. ARC. EXPOSURE TIME, 1/400 SEC

be thought of as a major factor in building up dielectric strength. Slepian[2] has strongly criticized this point of view, and has argued that diffusion rather than displacement is the vital factor in circuit interruptions.

Some information on the nature of the processes at work after current zero has been obtained by large-scale experiments with 50-cycle arcs in open air. By drawing arcs of 100–320 amp. at 10,000 volts, highly unstable conditions were obtained which gave rise to extinction in times of the order of 1 second.

Numerous photographs were taken to examine the progressive nature of arc instability and one of these, taken shortly after final interruption, is reproduced. This seems to indicate that interruption takes place at one pole earlier than the other and that the final current is a space-charge-limited discharge. Other photographs show that separate clouds of excited atoms or molecules can exist for appreciable times after current has been interrupted.

A fuller account is in course of preparation.

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Science Buildings,
University College,
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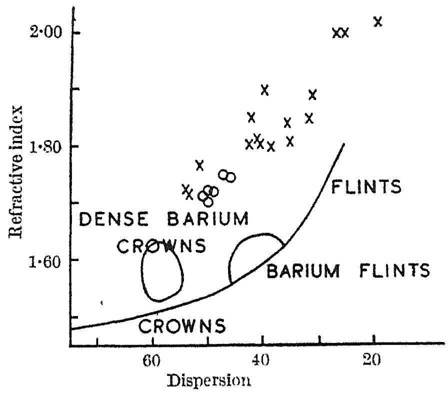
March 25.

[1] Kesselring and Kopplemann, *Arch. Elektrotech.*, **30**, 75 (1936).
[2] Slepian, *Trans. Amer. Inst. Elect. Eng.*, **60**, 162 (1941).

New Types of Optical Glass

The communication[1] by Messrs. Hampton, Bastick and Wheat is timely in that it directs attention to recently developed forms of optical glass that depart markedly in properties from those previously available and so provide optical designers with increased scope. Two statements, however, need correction. The refractive index limits of the new Kodak glass[2] are 1·71–2·02 and not 1·71–1·97, as stated; while the reference to the Kodak glass (known as *EK*2), having $nD = 1{\cdot}745$ and $V = 45{\cdot}8$, should not be taken to imply that it is now generally available. This glass is being made in England in our laboratories under the ægis of the Government and can be supplied for war purposes only.

The full range of optical properties now capable of realization as a result of our researches in the manufacture of glass from rare earth elements, with little or no proportion of silica, is shown in the accompanying figure. In support of the suggestion, by Hampton *et al.*, that the availability of glasses of such outstanding properties should stimulate work in lens design, it may be mentioned that many patents on lens design have been granted since the publication of our patents[2]; for example, B.P. 517,271; 523,061; 523,062; 535,501; 548,254; 548,255; 548,256; 548,251; 547,691; 554,291; 555,464; 555,404, to mention but a few. Some stimulation of lens design has, therefore, already occurred. Indeed, the Eastman Kodak Company was supplying lenses using the new glass before the present War, and is now using it in air-camera lenses on a large scale.



COMPARISON OF NEW KODAK GLASSES WITH OLDER TYPES. × REFERS TO GLASSES DESCRIBED IN B.P. 462,304: ○ REFERS TO GLASSES DESCRIBED IN B.P. 534,680.

So far the chief demand has been for the *EK*2 type; but we shall welcome any expression of views that will assist us in deciding which of the other members of the series should be made available.

W. G. Bent.
(Chairman.)

Kodak, Ltd.,
Kingsway,
London, W.C.2.

[1] Nature, **153**, 283 (1944).
[2] B.P. 462,304 and B.P. 534,680.

A Deluded Sparrow

We have been much intrigued of late by the actions of a cock house sparrow which has apparently become permanently attracted by its own reflexion in a glass window. The window forms a transom over a door and we first noticed the bird flying at the glass and pecking it violently. When this was continued for a long period, closer observation was made and the available facts collected. At the time of writing, the observation period has extended over more than a fortnight, and the bird shows no sign of deserting its post. The facts are as follow:

(1) Although there are many windows available in the immediate neighbourhood, attention is confined to one piece of glass. (2) Although the bird sometimes

absents itself during the day and always at night, it returns to the same place. We have not been able to discover its night resting place. (3) A piece of mirror was fastened to the outside of the glass by means of two bright 3 in. optics pins stuck into the frame. The mirror was loose behind the pins and the nature of the restraining force would be clear to a creature with intelligence. The presence of the mirror much excited the bird, and it made violent efforts to get behind the mirror. To do this it seized the pins in its beak and pulled. On two occasions it managed to remove the pins. (4) Occasionally during the day, regularly at about 8.30 a.m., it fetches pieces of food and tries to push them through the glass. The food is obtained nearby, where tits and chaffinches are fed daily. There are not many house sparrows on this particular feeding ground. (5) The bird shows considerable boldness, for people are constantly passing within a few feet of it. It made attacking rushes towards me when I was fixing the mirror in position. (6) At times the bird becomes tired and rests, sometimes on a small projection above the window, more frequently huddled close to the glass. When the mirror was in position it usually chose to huddle close to the mirror. In both these resting places it often utters its song.

We are interested in the implications of this evidence. In the first place, the deliberate and repeated efforts to remove the pins holding the mirror argues a certain amount of intelligence. Secondly, why should this bird ignore the available real birds which have the auxiliary attractions of smell and song and devote itself to a faint visual image? Surely this action cannot be purely instinctive. It argues a mental maladjustment; but this postulates the possibility of intelligence well above the instinctive level.

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April 3.

Wordsworth and Science

WORDSWORTH's apparent antipathy to science, as revealed by the quotations which Dr. Wigglesworth has given in NATURE of March 25 from his poetical works, has always provoked adverse comment, not unnaturally, from scientific men, and the quotation which has so long adorned the front page of NATURE has always borne a somewhat ironical air.

Yet it would seem that Wordsworth once had high hopes of science, and those who have read his famous introduction to the "Lyrical Ballads" will find there a more sympathetic view of it and, incidentally, a statement of what Wordsworth conceived to be the relationship between science and poetry. That relationship touches the crux of the matter, however we view it, but I do not propose to discuss it here. But it may be pointed out that when Wordsworth was writing, science had elaborated few of those great generalizations with which we are now familiar and which have some claim to be regarded as imaginative efforts paralleling those of the poet and artist.

It would also appear that Wordsworth's strictures were provoked less by science itself than by a certain narrow-mindedness he had found in 'scientists' of a sort with whom he had come into contact. His animadversions may not have been altogether undeserved; scientific workers of a certain type and calibre do not always exhibit in their mental outlook the fruits of a liberal education, assuming they have had one, and their attitude to poetry and the arts may be as unsympathetic and naïve as that which Wordsworth often displayed towards science. There was some ground for his revulsion from the cold detachment of science when the pursuit of it deadened the wider sensibilities of some of its followers. If poetry and the poets have their vapourings on occasion, science and the scientists have equally their aridities and myopic crudities.

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MR. SCRUTON's comments, with which I am in entire agreement, afford me an opportunity of making good an omission from my article. I omitted to state that my notes were limited to Wordsworth's poetical writings. The omission is indefensible; but the limitation I think can be defended, for Wordsworth's prose writings are immeasurably inferior to his poetry—as he himself surely felt when he hesitated whether to reprint the prefaces, and decided to include them at the end of his last volume where they could be read or not as the reader might desire.

As Mr. Scruton rightly says, the references to science which the prefaces contain are certainly more sympathetic. "The knowledge both of the Poet and the Man of science is pleasure". But still "Poetry is the breath and finer spirit of all knowledge; it is the impassioned expression which is in the countenance of all Science." Wordsworth concedes that "the remotest discoveries of the Chemist" may be "proper objects of the Poet's art" and "if the time should ever come when what is now called science . . . shall be ready to put on, as it were, a form of flesh and blood, the Poet will lend his divine spirit to aid the transfiguration, and will welcome the Being thus produced, as a dear and genuine inmate of the household of man". As Mr. Scruton asks in effect, if Wordsworth were alive to-day, would he have judged that that time had now arrived?

V. B. WIGGLESWORTH.

The Rare Gene Rh_y in Mother and Son

Wiener[1], and Race *et al.*[2,3,4], have independently described allelomorphs of the *Rh* gene. In addition to the six common to both investigations, the possession of the *St* serum enabled Race *et al.*[3] to define a seventh rare allelomorph, Rh_y.

The first family evidence that Rh_y is allelomorphic has just been obtained from the examination of the parents of the first Rh_1Rh_y donor recognized. His mother was Rh_1Rh_y, and his father's blood gave the reactions of Rh_1Rh_2. Three different sera of the *St* type were used in testing this family.

R. R. RACE.
G. L. TAYLOR.

Medical Research Council,
Emergency Blood Transfusion Service.
April 11.

[1] Wiener, *Proc. Soc. Exp. Biol. and Med.*, **54**, 316 (1943).
[2] Race and Taylor, NATURE, **152**, 300 (1943).
[3] Race, Taylor, Boorman and Dodd, NATURE, **152**, 563 (1943).
[4] Race, Taylor, Cappell and McFarlane, NATURE, **153**, 52 (1944).

TECHNICAL EDUCATION OF THE FUTURE

Dr. D. S. Anderson, principal of the Birmingham Technical College, recently addressed a meeting of the Birmingham General Branch of the Association of Scientific Workers, outlining his views on desirable changes in technical education in Great Britain.

Technical education, Dr. Anderson said, may be roughly defined as the education required by, and given to, personnel in industry, this personnel ranging from the skilled craftsman to the man doing laboratory development work of the highest character. At present the personnel of industry falls roughly into four groups: unskilled, semi-skilled, skilled and technical staff workers. Before examining the needs of the different groups, one should consider if any change in the grouping is to be expected in the post-war period. Dr. Anderson thinks such a change is to be expected. The increase of mechanization, of automatic processes and control, of scientific in place of empirical bases for much industrial practice, will all increase considerably the number of technical staff workers required. This development will be accompanied by the de-grading of many skilled operations to semi-skilled, and the net result is likely to be a decrease in the number of skilled workers and a corresponding increase in the number of technical staff workers and semi-skilled workers. While many may deplore the diminution in the number of skilled workers, the change really represents an advance.

The teaching institutions are concerned only with the skilled and technical staff workers. In Great Britain, apart from university degree courses, comparatively little special preparation or training is given before entering industry. Both the practical and theoretical training begin after entry, the theoretical training being taken, in the majority of cases, in the form of evening courses. This present system of training is unsatisfactory in three main respects: the system is slow, it is frequently unorganized at the works end, and the evening study imposes a very heavy burden on the young person. Students are frequently engaged on their technical studies right through their early twenties, and as a result of this prolonged period of technical study are prevented from developing an interest in cultural subjects and social affairs. One of the main post-war tasks in technical education should be an endeavour to shorten all forms of technical training. In the case of the skilled worker, this could be done by more systematic training in the works, and in the case of the technical staff worker it might be done by arranging some part of his technical course on a full-time basis, either at the beginning or end of the training period. On the Continent, full-time courses for technical staff workers prior to entering industry have been developed to a considerable extent and have proved of great value in supplying industry with a body of well-trained technicians.

Another post-war problem is concerned with teachers in universities and technical colleges. The quality of instruction in any teaching institution depends first on the teacher, secondly on the equipment, and thirdly on the building. While it is obvious that teachers must be carefully selected initially, very little has been given in the past for what one might call their 'care and maintenance'. The output of new knowledge in all branches of science and technology is so overwhelming that teachers have the greatest possible difficulty in keeping up to date. Technical teachers therefore require refresher courses to bring them up to date in their subjects, and periodical returns to industry to be brought up to date in industrial practice.

Two other points concerning teaching are that some subjects are best taught by practising specialists, and therefore firms should be prepared to allow senior members of their technical staff to act as part-time lecturers during the day. The other point concerns exchange of teachers. It would have a very stimulating effect if teachers could be exchanged between institutions such as universities and technical colleges, and also with American and Dominion institutions.

One of the problems which is ever present in a teaching institution is that of getting into a syllabus all the subject matter which is required. The boundaries of knowledge are advancing so rapidly in all directions that material has constantly to be added to all technical and scientific syllabuses, causing most serious overloading. Perhaps the best solution for this problem is for the universities and technical colleges not to attempt too much in their normal courses, and then to offer, after graduation, a wide range of special advanced courses for technical men in industry to take as required. If some such action were taken and the normal courses relieved of some of their present congestion, it might be possible to introduce a few 'liberal' subjects into these courses, and so remove the frequent and merited reproach that technical courses are too narrow.

RELATION OF ACADEMIC TRAINING TO INDUSTRY

The Swiss university journal *Schweizerisch Hochschule Zeitung* of September 1943 contains some long extracts from a report by Dr. H. Erb which has attracted considerable interest in Switzerland, and may have some bearing on post-war educational problems in other countries. It deals with the old and recurring problem of too many with academic training, a matter which has also exercised the minds of leading educationists elsewhere, notably in Germany a few years ago, when it filled many columns in the *Chemische Zeitung*, and also in the United States. The pressing needs and special conditions of war have submerged the problem in most countries to-day; but it is likely to emerge with still greater insistence after the War. Dr. Erb, while analysing its special features under Swiss conditions with much detail, does not suggest any very new or striking remedial or preventive measures other than those which have already been frequently urged in Great Britain and America: such, for example, as the warning against excessive concentration on the vocational side of education, at all events in a too narrow or specialized sense; the urgent need for raising the dignity of handiwork, of applying more thoroughly the doctrine of Morris and Kropotkin of mind-training through the hand; and a few generalities briefly dealt with below. So far as Switzerland is concerned, it is thought that more complete statistics and better analytical interpretation thereof, together with a greatly improved central organization for the transfer of university men into suitable openings in industry, are urgently needed.

If the number of young people leaving school and college is much larger in recent years than at the beginning of the century, it would seem that this is less marked in Switzerland than in certain other countries. For example, it is pointed out that, in 1930–31, per 100,000 of population, Germany had 63 *Abiturienten* (holders of school-leaving certificates or equivalent) whereas Switzerland had only 34. Japan and Rumania in 1934 had more than six times as many with academic training as in 1913. In the same period those of Holland increased by 146 per cent, of France 112 per cent, of Great Britain 83 per cent, and of Switzerland 59 per cent. According to Dr. Erb, the most disturbing aspect of this increase in quantity is the serious decline in quality: he thinks the standard, however measured, is definitely lower. The real problem, therefore, is not necessarily 'too many', but 'too many of the wrong type'. Mediocrity is said to be very noticeable in the universities and secondary schools. There are far too many *Brodstudenten*, or those who concentrate too closely on the vocational side to the neglect of the broader cultural and intellectual aspect. They specialize too soon and aim at passing through the technical schools as quickly as possible. The sole business of education, in their view, is to enable one to earn a living in some narrowly specialized sphere. We are faced again with the dangers of specialization, which have been debated *ad nauseam* in recent years.

Dr. Erb may have put his finger on one of the main sources of the trouble when he admits that school-building accommodation and number of teachers have not kept pace with the increased number of entrants. Teaching has become less individualistic than ever, and tends to savour of mass-production methods. It is difficult, of course, to be precise on this matter of quality; but both in the universities and in industry there are complaints that, despite the large increase in number of those with academic training, there is serious lack of the right type for the needs of industry and trade. If sufficient school space is wanting; if there are too few teachers and these are underpaid, with inadequate status and insufficient knowledge of the needs of business and industry, then the quality of the students must necessarily suffer. Certain it is that many of them show signs of hurried and inadequate training, both of mind and character—especially the latter: they are incapable of adapting themselves readily to the realities of life, from which they expect too much.

Although Dr. Erb complains that educational, or at least academic, statistics are not so good as they might be, and those which are available are not intelligently used, he thinks there is little doubt that the number of entrants to schools and universities tends to increase considerably in periods of industrial prosperity; but by the time these new entrants have finished their scholastic career, the boom period has been succeeded by depression, and they are condemned to unemployment; so much harder to bear in proportion to their academic qualifications. This is one of the tragedies of unemployment, raising larger issues than can be dealt with here; nevertheless, it must be remembered that, as already indicated, chances of employment for those with academic training—even in lean times—would be increased if they were more adequately or properly trained.

Reference is made also to the impact of social conditions and changes on the relative numbers of students at secondary schools and universities. The rights of man and consequent social philosophy of the nineteenth century led to the emancipation of the lower classes and of women, and to increasing demands for improved social status and better education. Dr. Erb considers that, in Switzerland, the exaggerated importance imputed to academic learning of the more showy or superficial type was particularly marked, and was closely associated with the growing social prejudice for black-coated respectability. Those who had not themselves attained to this status were anxious and determined that their children should do so; and this delusion, says Dr. Erb, will continue until it is more generally realized that the harder one studies the more certainly will he miss the road to wealth. This may be often true, but scarcely attains the dignity of a general proposition; and in any event strikes a slightly discordant note in its present context.

Among remedial measures suggested are a more careful selection of candidates for the school-leaving examinations, and greater attention to the importance of test or observation periods rather than exclusive concentration on examination results. In other words, the examination system is again under criticism, as is frequently the case to-day. Dr. Erb is strongly of opinion that the path to the university should be more strictly reserved to those above the general average who can best profit by university training. Not only should the school-leaving examinations (*Maturitätsschule* and *Auslese*) be considerably tightened up and revised, but also they should be supplemented by a system of character tests and observation periods, so that the real abilities of the student, not necessarily brought out by the usual examination, could be much more clearly and thoroughly ascertained. The examinations themselves should not usually be made more difficult in the sense of book knowledge—they are already too overloaded—but rather should include tests of character and personality not generally provided for in the examination papers.

CORRELATION OF THIXOTROPIC SETTING WITH DENSITY IN SILVER AMALGAMS

By DR. D. R. HUDSON
Heriot-Watt College, Edinburgh

SILVER and mercury form, by peritectic reactions at 276° and 127° C. respectively, intermetallic compounds represented very nearly by the formulæ, $AgHg$ and Ag_3Hg_4. They exist in space lattices of the close-packed hexagonal type with $a = 2 \cdot 987$ A., $c/a = 1 \cdot 62$, and the body-centred cubic type with $a = 10 - 10 \cdot 1$ A., respectively; the latter resembles the well-known γ-brass structure, but is not identical with it. In synthesized amalgams the range of stability of both species is small, probably not exceeding $\pm \frac{1}{2}$ per cent. Ag_3Hg_4 exists as native amalgam (argental or landsbergite) often in very well-formed crystals in the cubic system, corresponding closely in composition to the artificial product; $AgHg$ has not, so far, been reported in minerals, and Heide has suggested that this species does not occur native. Further, Ag_3Hg_4—known already to the alchemists as *Arbor Dianae*—can be obtained chemically by displacement of ions of either metal in solution by the action of the other. This is in accordance with the fact that the two standard

electrode potentials are almost identical: 0·799 v. for $Hg : Hg_2^{\cdot\cdot}$ and 0·798 v. for $Ag : Ag^{\cdot}$ at 25° C. In the hardening of plastic dental amalgams, Ag_3Hg_4 is formed by the reaction

$$\underset{\text{filings}}{Ag_3Sn} + \underset{\text{liquid}}{Hg} \rightleftarrows \underset{\text{dendrites}}{Ag_3Hg_4} + \underset{\text{solid solution}}{Sn(Hg)}$$
(Black, Troiano)

Densities of heterogeneous silver amalgams. The variation of density with composition has been determined for the heterogeneous range. Although the solubility of silver in mercury is small—only about 0·03 per cent at room temperature—they are quite fluid up to about 8 per cent. Between about 8 per cent and about 20 per cent silver, they are plastic on formation but 'set' on standing overnight; above 20 per cent they resemble hard 'Plasticine' rather than a heterogeneous mass, becoming gradually harder as the composition of the solid amalgam is approached. This was found to be 27·43 and 27·72 per cent in two separate experiments, by expulsion of the liquid phase (argentiferous mercury) under severe compression. By very careful handling of the set amalgams, it was found possible to use Archimedes' method down to about 13½ per cent silver; below this a special midget (2½ ml.) specific gravity bottle was used with success. The results are in fair agreement with the older determinations of Mey (1905), but are more consistent among themselves and probably rather more accurate than these; the very erratic values reported by Joule (1863) and Duczko (1935) were not confirmed. The density/composition curve shows small but distinct peaks at about 15 and 28 per cent, about 13·61 and 13·60 respectively, with minima at about 13 and 25 per cent, that is, 13·47 and 13·37. Between these points the curve is made up of straight lines and the *density is invariably above that calculated for a conglomerate* by summation of volumes. The silver content (at the mercury boundary) lies about midway between $(Ag_3Hg_4)_4$ proposed by Weryha (28·74 per cent), and $(Ag_2Hg_3)_{10}$ proposed by Berman and Harcourt (26·4 per cent), but a Hume-Rothery constitution $(Ag_5Hg_8)_4$ is definitely excluded by present results as well as by *X*-radiological and metallographic data.

Setting and Thixotropy. The amalgams set like plaster of Paris when they contain more than 8 per cent silver, but the process is very different, being completely and repeatedly reversible by pressure alone. During setting, the hardness increases; above 20 per cent one can obtain a robust mass which becomes quite plastic on kneading. This process is thixotropic, being due to the formation of a well-defined *réseau* of acicular crystals, which is quickly degraded under local pressure. Surplus mercury is held in this spongy structure as a result of its high surface tension, and in the mercury-rich amalgams may be seen to liquate out, leaving the dry *réseau* intact. It is rare to find thixotropy displayed so perfectly as in these amalgams.

Effect of setting on density. With the incidence of setting there is also a fall in density of 1–1½ per cent in a few days. In an extreme case, a 15 per cent alloy, which had stood undisturbed for more than two years, segregated into hard discrete equi-axed lumps and argentiferous mercury. Hard grinding was required to restore this to the plastic state, when its density was found to be normal and as much as 4 per cent greater. This ('pea' plus liquid) state is regarded as the ultimate limit of thixotropic setting, equivalent to complete spheroidization of cementite in steel. Two explanations are suggested.

(1) That pressure causes Murphy's peritectic reaction at 127° C. to go leftward at room temperature. $\beta + Hg \rightleftarrows \gamma$, or very nearly $3AgHg + Hg \rightleftarrows Ag_3Hg_4$.

(2) That the *réseau* consists of another intermetallic species, formed on standing and restored on kneading to the Ag_3Hg_4 originally present. This species might be either the same phase (27·7 per cent silver) in another space lattice with different physical properties, or a new intermetallic compound, possibly of different composition. Unfortunately, the relative proportion of jagged crystals and argentiferous mercury in the 15 per cent amalgam was not determined accurately. It may be estimated to be about 1 : 2, which would give an approximate silver content of about 45 per cent, the solubility of silver in liquid mercury being very small at room temperature. One may recall Murphy's β-constituent containing about 40 per cent mercury, which we have denoted AgHg.

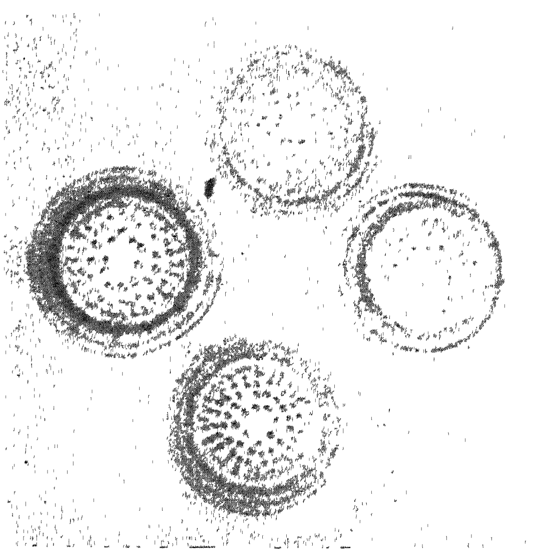
Dental amalgams. The unexpectedly low density of the set structure (spongy *réseau* plus argentiferous mercury) accounts very happily for the paradoxical expansion of tooth stoppings too rich in silver—a sharp change in setting characteristics takes place at 25·5–26 per cent. This bugbear led to the postulation of void formation by Gray, which *faute de mieux* has been accepted by Troiano and Gayler. However, in the specimen mentioned, in which the thixotropy had proceeded to the extreme limit, the measured difference of 4 per cent in density would require a void volume of as much as one eighth in the 'peas'. In view of their hardness and jagged nature, this is very difficult to accept. Moreover, it is somehow repugnant to scientific intuition to believe that voids can be formed on dendritic crystallization within a mother liquor with surface energy as high as mercury. Sullivan's amalgam of precipitated copper and mercury, now discarded in dentistry, is plastic but sets *hard* in a few hours, and can then be rolled or hammered. On kneading or heating, the mass recovers its plasticity.

Application to other physical properties. It is formally suggested that other anomalies in the physical properties of amalgams of alkalis and other metals, for example, viscosity, surface tension, electrical conductance, may also be due to thixotropy rather than to colloid formation.

A SIMPLE TECHNIQUE FOR PHOTOMICROGRAPHY

By Dr. W. N. LEAK

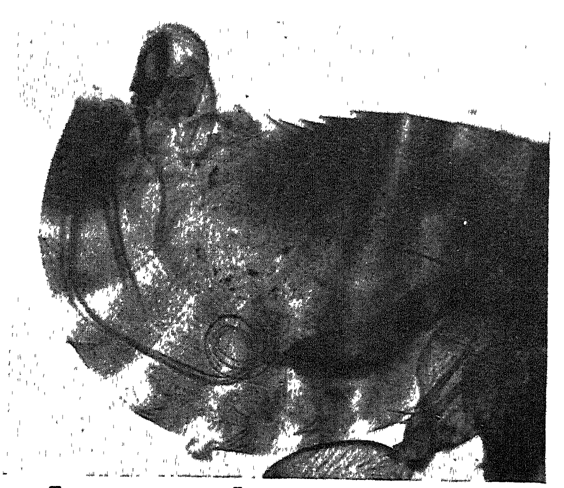
No record of a microscopical preparation can compare in value with a photograph, yet photomicrographs are often not taken so frequently as workers might wish because of the difficulty of doing the work personally or the interruption caused by sending it to a special photomicrographical department. There is, however, a simple method of obtaining excellent photomicrographs. The method depends on the fact that a camera will photograph a virtual image as easily as it will a real object. The image in a microscope is a virtual one, and if this is focused, as it normally is, at infinity, and a camera, also focused at infinity, is placed as near as possible to the ocular, so that all the light coming through the ocular enters the camera lens, a good photograph will result if the exposure is correct and the camera truly in line with the microscope tube. In actual practice this can be judged sufficiently well by eye,



Cestodiscus superbus. MEDIUM POWER (½ IN.). F.P.2 FILM. × 600 APPROX.

and the actual taking of a photomicrograph by this method presents no real difficulty whatever. We can ensure that the microscope image is focused at infinity either by using a focusing screen or a reflex camera, but much more simply by viewing part of the image through a small telescope (a 4-in. lens with a spare eyepiece in a cardboard tube makes quite a satisfactory one) focused for infinity and altering the fine adjustment until the image is sharp. Even this simple procedure is not necessary if the observer's eye is quite normal.

The excellence of the results obtained by this method seems to be due to two factors. First, practically all microscopes are constructed to give their finest results when used visually with an eyepiece, etc., and these conditions do not obtain in the ordinary methods of photomicrography. In the present method, however, we make the microscope give the finest visual image of which it and we are capable, and then photograph this image with the best photographic equipment at hand. The second reason is that in the ordinary way there is a considerable distance between ocular and plate, and this is liable to give rise to serious diffraction phenomena.



TAIL OF MALE FLEA. LOW POWER (1 IN.). H.P.2 FILM.

In this method, however, the length of these narrow pencils of light is scarcely greater than the focal length of the camera lens, so that diffraction troubles almost cease to exist.

With a 10-in. camera lens, the image on the film will be the same size as that seen by the eye, and such a film should stand considerable enlargement, though actually I find that my Leica with a 2-in. Elmar lens will reproduce practically everything I can see if fine grain film is used and enlarged about eight times. To illustrate this the photograph of *Cestodiscus superbus* was deliberately taken at the lowest visual magnification to show the marginal striations comfortably and the film enlarged eight times. A 4-in. or 5-in. lens might be better for general use, though longer exposures would be required. Kodachrome or Agfacolor film have even finer resolution than fine-grain film. With this method there is nothing to prevent the use of high-power eyepieces, for the close eyepoint and the shadows on the retina of blood vessels and opacities, etc., which make them objectionable for visual use do not affect the camera lens. I do not imply that this will give resolution beyond the resolving power of the objective, but it may well show details on the enlarged print which many eyes would fail to see visually.

I hope this brief description of some of the practical and theoretical points involved will make the method better known, for it has great possibilities in industrial and academic research, as well as in teaching. The method can naturally also be used for obtaining a photograph through any other instrument which uses an eyepiece, such as telescope, spectroscope, etc. A fuller description of the method appeared in the *British Medical Journal* of December 18, 1943, p. 787.

SOME SOUTH AMERICAN TIMBERS

TWO Leaflets, Nos. 31 and 32 (September 1943), have been issued under the auspices of the Department of Scientific and Industrial Research by the Forest Products Research Laboratory on "Some Foreign Timbers (South America), 3 and 4" respectively. The leaflets deal with the tree, timber, seasoning and mechanical properties, natural durability, insect attack, preservative treatment, working qualities, uses, and supplies available.

In Leaflet No. 31 two trees, the parana pine, *Araucaria brasiliana* and louro vermelho, probably *Ocotea rubra*, are discussed. The parana pine is a sub-tropical conifer attaining a height of 110–130 ft. with an average diameter of 2 ft. and clear bole of 60–70 ft. It occurs in the Andean region of South America at varying altitudes above 1,600 ft. and preferably on sandy soils. The timber is not resistant to decay, and sapwood very liable to develop a blue stain; it is easily worked by hand and machine tools.

Louro vermelho attains a height of more than 100 ft. and a maximum diameter of 3 ft. in some parts of its range, which probably includes Brazil and British Guiana and may extend further. The timber is said to be resistant to decay, probably more resistant than the heartwood of English oak; a character which, should it be confirmed, is high praise indeed. It is said to be easily workable with hand and machine tools.

Leaflet No. 32 gives notes on peroba rosa, *Aspidosperma polyneuron* (syn. *A. peroba*); and mandio-

queira, Qualea spp. The peroba rosa tree is said to attain a height of 125 ft. and a diameter of 4–5 ft. in the San Paulo State in Brazil. In less favourable parts of its range, however, it is often less than half this size. It is highly resistant to decay and is easily worked by hand and machine tools.

The name 'mandioqueira' refers to several closely related species of Qualea in the Amazon region. In Central and Southern Brazil the same name is applied to species of Didymopanax, with timber of entirely different character. In Brazil mandioqueira occurs as a large tree mainly of the uplands and the banks of running streams. It probably averages about 100 ft. in height at maturity with a diameter of about 2 ft. About thirty species of this genus have been recorded from Brazil and the adjoining countries. The timber is moderately hard to work by hand or machine tools, being somewhat cane-like in its resistance to cutting. It is said to be like the African iroko (*Chlorophora excelsa*) in many respects.

A factor, not without importance in connexion with the research work undertaken by the Forest Products Research Laboratory on these foreign timbers, is in its application among other uses to their suitability or otherwise for plywood conversion.

PETROLEUM: PAST, PRESENT AND FUTURE

THE petroleum supply situation is causing considerable comment in the United States at the present time and no doubt there is the usual crop of rumours concerning imminent scarcity of this product, so necessary in peace-time, so indispensable at this critical period of warfare. Dr. Per K. Frolich has given (*Science*, Nov. 26 and Dec. 3, 1943) a candid picture of the present position, supported by data from a number of reliable sources. Unhesitatingly he states that eventually a shortage in natural petroleum will occur; but he is equally emphatic that when that time comes it should be possible to obtain all necessary hydrocarbon products from alternative sources. Moreover, there is nothing to indicate that there will be any break in continuity of supply of gasoline and other petroleum derivatives. Nothing more nor less is envisaged than the gradual introduction of synthetic products into the industry as the supply of natural hydrocarbons declines.

Methane, the major constituent of natural gas, can be converted into gasoline by the Fischer-Tropsch process, used commercially in Germany for some considerable time; the heavier constituents can be processed by cracking or dehydrogenation, followed by polymerization and alkylation. Oil can be recovered from shales by 'retorting' under suitable conditions of temperature and pressure. The Tertiary deposits of the Rocky Mountain Region, the Devonian black shales of Indiana and Kentucky, and the cannel shales of Pennsylvania and West Virginia represent a large potential supply of liquid hydrocarbons. In 1928 these deposits were estimated by Dean E. Winchester as capable of producing 92 billion barrels of oil. In addition, there are the Canadian deposits of tar sands which spread over thousands of square miles.

These potential reserves of liquid hydrocarbons are, however, insignificant when compared with the quantity which could be produced from coal deposits. H. L. Ickes, Petroleum Administrator of the United States, estimated in August 1943 that available coal reserves can provide all the synthetic fuel needed for a thousand years and still leave enough for present purposes.

So far these alternative sources of liquid hydrocarbons have scarcely been tapped in the United States, whence before the War came 63 per cent of the world's petroleum requirements. Indeed, it is unlikely that they will be exploited to any great extent for some time to come. The next phase of development in the petroleum industry, as envisaged by Dr. Frolich, will be characterized by further technological progress, increased drilling for oil on a world-wide basis and necessary adjustments in supply and demand. All these factors will tend to prolong the availability of natural resources and, when peace comes, fear of their imminent exhaustion will loom correspondingly less large.

BOMBAY ISLAND

THE president of the Section of Geology and Geography at the thirty-first session of the Indian Science Congress at Delhi last January was Dr. A. S. Kalapesi, of St. Xavier's College, Bombay. Appropriately, Dr. Kalapesi chose as the subject of his presidential address a review of the geographical and geological features of Bombay Island. His discourse on its geographical aspects is of much interest to those who know Bombay, especially because in describing the evolution of the present unitary island from the earlier seven separate islands (the *Heptanesia* of Ptolemy) Dr. Kalapesi mentions also the derivation of many of the well-known place names. The word Bombay itself, for example, is now generally accepted as derived from the name, 'Mumba Devi', of the tutelary goddess of the first known inhabitants of these islands, the Kolis.

Geologically, Bombay Island is a portion of the great spread of Deccan Trap lavas occupying so much of Western India, and is composed essentially of westerly dipping sheets of this basaltic formation with a freshwater intercalation, the whole being masked in places by recent sea and lagoon deposits. That there have been geologically recent changes of level is proved by the presence of a raised sea beach in the centre, and of a submerged forest on the east side of the island. The sedimentary bed mentioned above is of special interest as it contains numerous beautifully preserved fossil skeletons of small frogs. The lava sheets of Bombay are thought to be in part of extrusive origin, like the main mass of the Deccan Trap lava flows, and in part of slightly later intrusive origin.

It is evident from Dr. Kalapesi's address and the writings of some of his predecessors (Carter, Wynne and Fox) that what is now needed is a detailed geological study of Bombay Island, including a careful petrographical study of the various rock types, fortified by chemical analyses. At present views differ, for example, on whether the lava flow that constitutes Malabar Hill, whereon is situated Government House and many of the residences of the merchant princes of Bombay, is composed of basalt, andesite or trachyte. There should be no room for doubt on such a point as this. The task suggested seems a suitable one for geological residents of Bombay, such as Dr. Kalapesi and his students.

L. L. FERMOR.

FORTHCOMING EVENTS

Monday, May 8

SOCIETY OF CHEMICAL INDUSTRY (PLASTICS GROUP) (at the Waldorf Hotel, Aldwych, London, W.C.2), at 2.30 p.m.—Annual General Meeting. Mr. H. Langwell: "The Technique of the Scientific Lecture".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Mr. K. de B. Codrington: "Valleys of the Hindu Kush".

Tuesday, May 9

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Prof. H. J. Fleure: "Some Islamic Reactions to Modern Life around the Eastern Mediterranean".

ILLUMINATING ENGINEERING SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5 p.m.—Annual General Meeting. At 5.30 p.m.—Sir Charles Darwin, K.B.E., F.R.S. "Tolerances and their Effect on Physical Measurements".

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London S.W.7), at 6 p.m.—Mr. David Charles: "Practical Cure of Convergent Verticals".

Wednesday, May 10

SOCIETY OF CHEMICAL INDUSTRY (CHEMICAL ENGINEERING GROUP) (at the Waldorf Hotel, Aldwych, London, W.C.2), at 12.15 p.m.—Twenty-fifth Annual General Meeting.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Sir Richard Winn Livingstone: "Education, To-day and To-morrow", 9: "Adult Education".

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. L. Carr: "Remote Switching by Superimposed Currents".

Wednesday, May 10—Thursday, May 11

INSTITUTION OF NAVAL ARCHITECTS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 2.30 each day.—Boiler Symposium on the Application of Water-Tube Boilers to Merchant Ships.

Thursday, May 11

IRON AND STEEL INSTITUTE (at 4 Grosvenor Gardens, London, S.W.1), at 10.45 a.m.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Annual General Meeting. Mr. R. J. Halsey: "Modern Submarine Cable Telephony and the Use of Submerged Repeaters".

INSTITUTION OF ELECTRICAL ENGINEERS (CAMBRIDGE AND DISTRICT WIRELESS GROUP) (at the University Engineering Department, Trumpington Street, Cambridge), at 8.15 p.m.—Dr. E. B. Moullin: "The Contribution of Cambridge to Radio Engineering".

Friday, May 12

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Mr. G. L. Camm: "An Analysis of the Motion of Cepheid Variable Stars, with reference to Galactic Rotation and Absorption"; Mr. E. H. Linfoot: "The Schmidt-Cassegrain Systems and their Application to Astronomical Photography".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Dr. W. T. Astbury, F.R.S.: "Fibres and Fabrics, Old and New—Their Chemical Structure and Physical Properties".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Exhibition of Technical Films.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DISTRICT ENGINEER by the Ceylon Government Railway—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.926A) (May 10).

SENIOR POST under the AERONAUTICAL INSPECTION DIRECTORATE (applicants should possess a first-class Honours Degree in Physics or a recognized equivalent, have had industrial radiological experience, be conversant with the various modifications of the technique of X-ray crystal analysis, and be capable of carrying out independent *ad hoc* scientific investigations in electro-physics)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.499A) (May 10).

LECTURER (man or woman) IN GEOGRAPHY AND MATHEMATICS—The Principal, Dudley and Staffordshire Technical College, Dudley (May 12).

LECTURER IN PRODUCTION ENGINEERING at the Coventry Technical College—The Director of Education, Education Offices, Coventry (May 12).

LECTURE-ASSISTANT IN MATHEMATICS—The Registrar, The University, Manchester (May 13).

GRADUATE ASSISTANTS IN MECHANICAL ENGINEERING, ELECTRICAL ENGINEERING, and GRADUATE (or equivalent qualification) in BUILDING AND STRUCTURAL ENGINEERING, at the Darlington Technical College and Technical School—The Chief Education Officer, Education Office, Darlington (May 15).

SPEECH THERAPIST (female, full-time)—The Director of Education, Huntriss Row, Scarborough (May 15).

LECTURER IN MATHEMATICS—The Principal, Kingston Technical College, Kingston, Surrey (May 15).

ASSISTANT LECTURER IN SCIENCE—The Principal, Domestic Science College, Knighton Fields, Leicester (May 17).

ASSISTANT CIVIL ENGINEERS (temporary) on the Staff of the Ministry of Home Affairs, Government of Northern Ireland—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.940A) (May 17).

ASSISTANT CIVIL ENGINEER (temporary) on the Staff of the Ministry of Finance, Government of Northern Ireland—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.941A) (May 17).

DEPUTY ELECTRICAL ENGINEER AND MANAGER (temporary) or CHIEF ASSISTANT ELECTRICAL ENGINEER (temporary) (location, City of Chester)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.807XA) (May 17).

CHEMISTS for service with Petroleum Company in the Middle East—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.1843X) (May 17).

TWO DEMONSTRATORS IN PHYSIOLOGY (one for BIOCHEMISTRY)—The Secretary, King's College, Strand, London, W.C.2 (May 18).

ASSISTANT TECHNICAL OFFICER—The Executive Officer, Essex War Agricultural Executive Committee, Essex Institute of Agriculture, Writtle, Chelmsford (May 20).

LECTURER IN THE DEPARTMENT OF MATHEMATICS—The Registrar, University College, Singleton Park, Swansea (May 20).

DRAINAGE AND IRRIGATION ENGINEER by the Gambia Government—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E. 950 A) (May 24).

LECTURER in charge of the DEPARTMENT OF BOTANY—The Registrar, University College, Leicester (May 27).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

DEPUTY ENGINEER of the Sheffield Waterworks Undertaking—The General Manager and Engineer, Waterworks Office, Town Hall, Sheffield 1 (May 31).

CHAIRS OF PHILOSOPHY, ZOOLOGY and COMPARATIVE ANATOMY—The Registrar, University College, Cathays Park, Cardiff (May 31).

CHAIR OF BOTANY—The Registrar, The University, Sheffield (June 1).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

CHIEF ENGINEER AND GENERAL MANAGER of the Gloucester Electricity Undertaking—The Town Clerk, Guildhall, Gloucester.

ASSISTANT LECTURER IN SOCIAL PHILOSOPHY to assist in the teaching of the elements of Ethics and Social Philosophy, and an ASSISTANT LECTURER IN GEOGRAPHY to assist with the teaching of Geography—The Acting Secretary, London School of Economics, The Hostel, Peterhouse, Cambridge.

SCIENCE AND MATHEMATICS MASTER, for English High School for Boys, Istanbul—The British Council, 3 Hanover Street, London, W.1 (endorsed "Istanbul").

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF INORGANIC AND PHYSICAL CHEMISTRY—The Registrar, The University, Liverpool.

ASSISTANT MASTER FOR ENGINEERING SUBJECTS in the Burton-upon-Trent Technical Institute and Junior Technical School—The Secretary and Director of Education, Education Offices, Guild Street, Burton-upon-Trent.

DIRECTOR OF THE BRITISH ELECTRICAL AND ALLIED INDUSTRIES RESEARCH ASSOCIATION—The Chairman of the Council, B.E.A.I.R.A., 15 Savoy Street, Strand, London, W.C.2.

RESEARCH ASSISTANT (BIOLOGY and/or PHYSICS) for Hospital Laboratory—The General Superintendent, Christie Hospital and Holt Radium Institute, Withington, Manchester 20.

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INTERNATIONAL CO-OPERATION IN TELECOMMUNICATIONS

THE machinery of international co-operation, which has been allowed, in the political sphere, to break down from frictional wear and tear, is being hopefully re-examined as a prelude to reconditioning or reconstruction. Chatham House has been happily inspired to inaugurate a series of monographs on international transport and communications, and the series opened appropriately with the discussion of international telecommunications*: appropriately, because the Union to which was first entrusted in 1865 the organization and regulation of telecommunications was, as the author of the monograph justly says, "One of the earliest, and also one of the most successful organs of international collaboration". The structure, which was founded on the International Telegraph Union, grew large and somewhat sprawling with the rapid expansion, first of line telephony, and later of radio communication systems. It was redesigned and given good architectural form at a conference held in Madrid in 1932. There the International Telecommunication Union was created as the supreme organ of collaboration in these fields. Brigadier-General Sir Osborne Mance's book is an admirable guide to the past history of international telecommunications, and to those considerations which will be important in the planning and management of their future.

It has been remarked, by those who have had the privilege of participating in the international conferences on telecommunications and on meteorology, that in general the technical world has managed these partial Leagues of Nations more successfully and fruitfully than did the political world its more ambitious and naturally less tractable League. These successes were in part due to the simple and inescapable conviction that the choice lay only between collaboration and chaos. But that has been demonstrated to be true also in the political sphere. There is justification for the claim that the community of interest and mode of thought engendered by a common technique was a major factor in the success attained. The secure foundation of the common technique was, in turn, that universal freedom of interchange of scientific knowledge and thought which has been an enduring encouragement to all who believe that man can learn to forget frontiers without forgetting national pride.

The problems of line communication are of great technical interest, but they are technically, organizationally and politically of a pristine simplicity when compared with those of radio communication. Mutual interference through common use of a medium which facilitates the passage of intelligence to world-wide distances, at an expenditure of power which may be less than that of a pocket torch, can only be avoided by skilled adherence to stringent regulations. The difference in the area served by radio communications on different wave-lengths, the variability of the

* International Telecommunications. By Brig.-General Sir Osborne Mance. (Issued under the auspices of the Royal Institute of International Affairs.) Pp. xii+90. (London, New York and Toronto: Oxford University Press, 1943.) 7s. 6d. net.

area with the time of day and with the season, the limitation of the service by noises of natural origin —mainly radiated from lightning flashes—all these and similar factors lead to keen competition for wave-length channels, which must be allocated internationally if radio peace is to be maintained.

It has been suggested that allocation should be based on two principles which seem unanswerable in the abstract, but which have not yet been accepted as a basis of action. The first principle is, in its broadest form, that first claim should be conceded to those services in which a metallic conductor cannot be used to link sending to receiving station. Thus maritime and aircraft services would be given absolute priority; and the use of line telegraphy and telephony would be encouraged, in preference to radio links, wherever they could assure a service. The second principle is that where services with a legitimate claim (within the first principle) to radio allocations come into competition for channels, preference should be given to the one which is of the highest social importance. In the absence of an agreed set of principles such as these, allocation has remained a matter for bargaining, compromise and successive readjustments. Difficult as would be the working out of the ethical, organizational and political problems implicit in the "highest social importance" criterion, the absence of even this golden foot-rule leaves still greater difficulties to be faced. Prestige, propaganda and profits are noisier claimants than principles.

The maritime services demand not merely straightforward communication of the content of the spoken or the written word, not merely that vital aid to determination of longitude provided by time signals, the value of which depends on the infinitesimal time they lose in travelling halfway round the world. They require, too, those radio aids to navigation which depend on the fact that it is not difficult to measure, at a receiving station on ship or shore, the bearing, relative to true north or to the ship's heading, from which signals of known place of origin are coming in. Radio beacons and direction-finding services require a special place in the most-favoured-service category.

Still more exacting are the claims of air transport. Radio, with its lusty infant progeny of 'radar' devices, offers the air line of the immediate post-war future a complex of communication, navigational and safety services which leave only one major hazard in all-weather flying. But such services demand monopoly use of a considerable range of wave-lengths, denied to any other user within a wide area which may, in some cases, be a world area.

These are the services which would stand indisputably at the top of the priority list based on the first general principle; the broadcasting services would certainly claim first place in the "social importance" scale—even though the cynic will suggest that a mad dog may, while he runs free, be of more immediate social importance than a young Pasteur.

It is not too soon for the United Nations to be considering now a sound double framework of basic principles and technical performance in the broad field of international communications. Within such a framework must be fitted the post-war solutions of problems which will have become more numerous and more pressing with war-time progress in radio and with the demands of rehabilitation. It may well be believed—and hoped—that no such opportunity for rationalization and reconciliation of competing claims in the field of international communications will ever again present itself.

NATURE CONSERVATION AND ECOLOGY

In his recent broadcast address, the Prime Minister rebuked those "comfortable people who . . . would rather postpone building homes for the returning troops until they have planned out every acre in the country to make sure the landscape is not spoiled". It is not, perhaps, immediately clear who are the people thus referred to, but we can be sure that the scientific advocates of nature conservation are not among them. They, at any rate, will be content if the place allotted to them in the scramble for post-war priorities is not too near the end of the queue. This is made clear in an admirable pamphlet recently published by the British Ecological Society*, in which the human or social background is constantly kept in view.

When the Nature Reserves Investigation Committee was appointed in response to an official request in 1942, a committee of the Ecological Society was already engaged in considering the same subject and was able to assist in the inquiries. When the first-named Committee's report was published (see NATURE, June 26, 1943) the work of the Ecological Committee might have been thought to require no further record. It was considered, however, that the distinctively ecological point of view deserved to be independently formulated, and the report now published is designed to do this. It forms a very valuable supplement to the earlier report, and its extended treatment of the subject may be found more attractive by many readers.

Ecologists are, of course, primarily concerned with the scientific (or research) and educational aspects of nature conservation, though it is emphasized that these only rarely conflict with, and often reinforce, the claims of amenity and recreation. The subjects of ecological study are less the individual species than the interdependent aggregations or 'communities' of animals and plants that occur in Nature, and ecologists are specially desirous of preserving these communities. "Oak, beech and ash trees, heather and bilberry and bog-moss are very unlikely to disappear altogether from the country, but their continued existence as species is of very limited use to the ecologist if all the oakwoods, beechwoods and ashwoods, the heather and bilberry moors and the undrained *Sphagnum* bogs are destroyed or so modified that they no longer

* "Nature Conservation and Nature Reserves". Report drawn up by a Committee and approved by the Council of the British Ecological Society. Pp. 38. October 1943. (Cambridge University Press.) 1s. 6d.

represent natural plant communities." For this reason the ecologists regard with some suspicion the term 'species reserves' given by the Nature Reserves Investigation Committee to the category of reserves intended to secure the survival of rare or very local species. In every case it is the habitat rather than the individual species to which the conservators must direct their efforts, and 'species reserves' are simply 'habitat reserves' differing from others in the same category only in the reasons for their selection.

The ecologists distinguish between 'natural' and 'semi-natural' communities of plants, with their associated animals, and point out that efforts at conservation should embrace the latter as well as the former. For example, in the southern parts of the British Isles, hedgerows and small copses provide the main habitat for many species of wild flowers and nesting sites for perhaps the majority of our smaller birds. Their destruction, advocated and perhaps inevitable in the interests of large-scale mechanized farming, would not only destroy much of the charm of the lowland countryside but also might have indirect effects harmful in the long run to agriculture, such as the elimination of insectivorous birds and even the erosion of the lighter soils by wind or water.

It may perhaps be doubted whether the distinction drawn by the ecologists between 'natural' and 'semi-natural' communities is of much practical significance in Great Britain. Communities which are 'natural', in the sense that they owe none of their features to the effects of human activities, are probably very rare and are to be looked for only on the tops of the highest mountains and the wilder parts of the sea-coast. Further, the distinction is not always consistently adhered to even in the Ecological Committee's report itself. Thus, on p. 8, the rough grazings of hill pastures "which have never been ploughed or manured" are stated to consist of "entirely wild vegetation", while on p. 4 it is stated that "most of the grassland of these hill grazings owes its present condition largely to the continual nibbling of sheep". It may be added that land which is constantly grazed can scarcely be described as never having been manured.

That part of the report which deals with the relation of nature conservation to the activities of the Forestry Commission is of particular interest. In view of the urgent national need for coniferous timber, it is inevitable that the chief attention of the Commission must be devoted to supplying this. Coniferous plantations are admittedly not picturesque, and their associated fauna and flora are impoverished and lacking in interest to the ecologist, although "the plantations will lose much of their repellent uniformity and ecological poverty as they grow older". The report notes with satisfaction, however, that the Commission has not lost sight of more remote interests, as, for example, in setting aside as 'permanent forest reserves' certain areas of old, undisturbed, deciduous woodland, and it suggests that the Commission might be given a broader mandate to enable it to deal with questions at present excluded from its scope.

The Ecological Committee takes a similarly realistic view of the relations which should obtain between nature conservation and agriculture and game preserving. In connexion with the last-named subject, the Committee rightly deprecates attempts to introduce exotic species of animals. Its condemnation might have been more emphatic. In the past, such introductions have been mostly due to the whims of individual landowners; but it is a regrettable fact that even to-day one does occasionally meet people whose idea of a nature reserve seems to be a combination of Whipsnade with the less formal parts of Kew Gardens.

As regards the administrative machinery which it would like to see set up for the establishment and supervision of nature reserves, the Committee of the British Ecological Society cordially endorses most of the recommendations of the Nature Reserves Investigation Committee. While the latter, however, looks forward to the institution of a national nature reserves authority under the Ministry of Town and Country Planning, the Ecological Committee would like to see a national wild-life service with a status similar to that of the Medical Research Council, under the Privy Council, to embrace the whole field of the native fauna and flora of Great Britain. To this, presumably, would have to be added the conservation of geological sites advocated by the Nature Reserves Investigation Committee. Doubtless we may have to wait a long time to see the full development of such large-scale plans, but meanwhile there is much that might be done to educate the general public in the meaning and methods of nature conservation. For this purpose the pamphlet issued by the British Ecological Society deserves a wide circulation.

WHALEBONE WHALES IN THE ANTARCTIC

The Southern Stocks of Whalebone Whales

By Dr. N. A. Mackintosh. (Discovery Reports. Issued by the Discovery Committee, Colonial Office, London, on behalf of the Government of the Dependencies of the Falkland Islands.) Pp. 197–300. (Cambridge: At the University Press, 1942.) 15*s*. net.

THE main object of the research conducted by the "Discovery" Committee is the investigation of the biology of the economically valuable whales frequenting Antarctic waters. A number of "Discovery" reports dealing with various aspects of the subject have already been published, and Dr. Mackintosh's present paper incorporates much of this material in a comprehensive survey of pre-war conditions. At the present time, whaling is at a standstill, and the stock of whales is enjoying a respite from pursuit likely to extend to the end of the War. The effect of this war-time period of protection can only be measured comparatively in terms of conditions prevailing when whaling ceased. From this aspect, Dr. Mackintosh's review is of particular value. It should be emphasized that his memoir is by no means merely a compilation of already published data. It contains a great body of additional informa-

tion which the author has analysed, and also uses statistics of the whaling industry to provide a statement on the condition of the southern whale stocks which will be invaluable in the investigations necessary when whaling becomes active again.

The specific identity of the main constituents of the Antarctic catch—blue, fin and humpback whales—is briefly considered. This is followed by a section of more general interest in which weights of large whales are stated and formulæ for assessing weight from linear dimensions examined.

The remarkable exclusiveness of krill (*Euphausia superba*) as the food of all the whalebone whales while in the Antarctic has been proved by examination of many thousands of stomach contents. The record of any organism other than krill is so infrequent that its presence can be attributed entirely to chance; and the deterioration in the condition of whales which have moved to warmer waters where this crustacean is not available gives further proof of its importance in the cetacean diet.

The parasites infecting whales, particularly the ecto-parasites, are interesting not only from the range of forms which occurs—Diatomacea, Protozoa, Amphipoda, Copepoda and Cirripedia all figure in the list—but also because of the indications some of them give of migratory movements. Only whales which have been a long time in cold water carry a heavy film of diatoms; on the other hand, the copepod Pennella, a parasite in warmer water, indicates by its actual or recent presence in whales killed in the Antarctic that the cetaceans had not long migrated from lower latitudes.

Figures for the mean length at which sexual maturity is attained have been confirmed or made more definitely known. From this information, obtained by careful examination of genitalia and accurate body-length measurement, it has been possible to compute the proportion of mature and immature whales in the commercial catch, given only species, sex and length of the animals involved. The old corpora lutea in the ovaries, which are persistent, it may be throughout the life of the animal, have helped to provide a solution for many of the problems associated with the sexual cycle. Although much has still to be done, it is clear that the advance in knowledge of this aspect of the work has been most satisfactory.

The statistics of the whaling catch are considered in some detail. An idea of the scope of the industry is gained from the number of whales killed at southern whaling centres between 1904 and 1939. It is 636,426. Although the catches at tropical and sub-tropical stations are included in this total, the preponderating importance of the operations in the Antarctic, including South Georgia, is shown by the fact that 509,784 whales, or more than 80 per cent of the total, were slaughtered in those regions. In the last prewar season alone 35,770 whalebone whales were taken in the Antarctic.

Marking of whales and the subsequent recovery of the darts from harpooned animals serves a dual purpose. The first and obvious one is the information about migration which can be obtained from recovered darts, and one of the most important new contributions in the paper is concerned with the difference between the humpback and the large rorquals in migration behaviour. During the Antarctic summer, the humpbacks are not distributed uniformly in the far south but are grouped in clearly defined communities, the position of which, Dr. Mackintosh has shown, can be correlated with winter haunts of this species on the South American, African, West Australian and New Zealand coasts. The evidence of marking indicates that each group of humpbacks keeps to its own approximately north–south migration route and that there is little intermixing of adjacent communities. The migrations of the blue and fin whales are less well defined. In winter they disperse in the warmer waters of the southern hemisphere to a greater extent than the humpbacks, and although in the southern summer they have a tendency to concentrate in the same areas as the humpbacks and to return to the same part of the Antarctic after their northward migration, unlike the humpback they sometimes move from one area to another.

But in addition to its primary intention, whale marking can also be used to give an indication of the proportions in which the species distinguished may be considered to be represented in the areas covered. The species ratio of whales marked is blue 13 per cent, fin 76·3 per cent, humpback 10·7 per cent. These percentages bear a remarkable similarity to the species ratio of whales observed at sea by the "Discovery" Committee's vessels, namely, blue 16·5 per cent, fin 77·1 per cent and humpback 6·4 per cent. The percentage of blue, fin and humpback whales killed in the Antarctic in the 1933–38 period was 44, 41 and 14 per cent respectively, figures which point to a disproportionately intensive attack on the population of blue and humpback whales. That the stock of these two whales is being depleted is shown by the progressive decline in the percentage of the two species in the annual catch, by the reduced size and age of the whales killed, and particularly in the humpback by its virtual disappearance in areas where formerly it was abundant. Consideration of this problem is made difficult by a number of qualifying factors, such as the development in the efficiency of hunting methods, regulations protecting certain classes of whales, weather conditions, area exploited, relative economic value of different species and so on.

The report contains much that is of interest to the general biologist, but for those whose concern is the conservation of the stock of whales in the south it must be an indispensable work of reference.

F. C. FRASER.

STATISTICS OF LITERARY VOCABULARY

The Statistical Study of Literary Vocabulary
By G. Udny Yule. Pp. ix+306. (Cambridge: At the University Press, 1944.) 25*s*. net.

A NEW book by Mr. Udny Yule is a statistical event which, though of great rarity, is all the more welcome when it occurs. This, however, is not a formal treatment of a subject which has already shaken down into definite lines of development, or even a systematic introduction to such a subject. Rather is it an account in volume form of Mr. Yule's incursion into a novel and interesting field of research.

That authors have their idiosyncrasies in the choice and use of words has been recognized by literary critics from the earliest times; but attention in the past has been mainly directed to the peculiar or unusual words, or at best to qualities of verbal

style which are so obvious as to require no labour to establish their existence, such as the Germanic vocabulary in Carlyle's work or the Anglo-Saxon preferences of William Morris. Studies of these matters, useful as they are, did not tell Mr. Yule what he really wanted to know about an author's vocabulary. The statistician is interested in populations even of the most ordinary things, and what Mr. Yule wished to discover was what the vocabulary was like *as a whole*. "To tell me that there is a small mole on Miranda's cheek may help me to identify the lady, and may in conceivable circumstances be quite useful information to the police, but it hardly amounts to a description of her alluring features." Mr. Yule might have added that identification by individual feature is a dangerous procedure in literature. Shakespeare's use of legal words and phrases has been claimed as a favourable argument for the Baconian heresy, and the use of conventional adjectives of colour in the Iliad has been supposed to confirm the legend that Homer was blind.

Mr. Yule, then, embarks on the task of forming a picture of a writer's whole vocabulary. He has concentrated his work on nouns, as being most likely to be characteristic, and has drawn his material from five main sources—the Bible, the works of Thomas à Kempis, those of a rival claimant to the authorship of the "Imitatio Christi", Gerson, the essays of Macaulay and the works of John Bunyan. Even though help could be obtained from a concordance in some cases, this involved a fairly extensive inquiry by sample. There is an interesting account of the technique used to obtain really representative samples from the heterogeneous material available. Mr. Yule finally decided on what he calls "spread" sampling, a sort of stratification which distributes the sampling uniformly over the population.

The frequency-distributions of nouns so obtained have interesting features in common. The majority of nouns—about half the vocabulary—occur only once, fewer occur twice, fewer still thrice and so on, the distribution being J-shaped with a long tail furnished by a few words occurring very frequently, such as *Deus* in the "Imitatio" and *King* in Macaulay's essay on Hampden. Mr. Yule recognizes that perhaps for larger samples the modal frequency might be at two or three occurrences and tests the possibility with typical ingenuity, not by extending his already extensive samples but by applying himself to a document in which the writer's vocabulary is severely limited, the Gospel of St. John in Basic English; even here he finds the highest proportion of nouns, about 25 per cent, occurring only once.

The *litterateur* who resents having the cold light of science turned on inspired passages from the classics in this way may stop here and ask whether all this counting and measuring tells him anything he did not already know. If he is prepared to learn, there is in fact a good deal of benefit he can derive from the exact type of study exemplified in Mr. Yule's work. A single by-product of the frequency-distributions will suffice to exemplify their suggestive character. Suppose a reader with no previous knowledge of Latin, and wishing to study medieval authors in the original, decides to begin with the "Imitatio Christi"—an excellent choice because of its simple style. Suppose a noun has to occur a dozen times before its meaning is firmly stamped on his memory. Then at the end of a first reading he will remember 140 out of 1,168 nouns occurring in the book, only about one eighth of the vocabulary encountered.

There are several peculiar features of the word-distributions, one of which is that they change their form as the size of sample increases because of the appearance of new words. Mr. Yule devises a characteristic of the distribution which is independent of the size of sample and permits of comparison between different authors. The work is closely related to the theory of accident distributions. If the author's store of words is regarded as a population with varying proneness to occurrence, the observed distribution may be considered as a compound Poisson. There is one important difference from accident statistics as usually available, because we do not know the number of words at risk which have 'escaped accident', that is to say, have not occurred. But this difficulty is successfully surmounted; and if our carping critic dismisses as absurd the idea that an author selects words out of his store like a man taking tickets at random out of a hat, he has still to explain the fact that Yule's characteristic *is* practically independent of sample size in all the examples he discusses.

In a chapter on "Sources of Fallacy", Mr. Yule does much to clarify the problems with which he is faced and incidentally exhibits serious shortcomings in the work of some of his predecessors. He then turns to a discussion of the English vocabularies of Macaulay and Bunyan. The chance observation that the proportions of nouns classified by initial letters differed very considerably between the two led him to a study of etymological differences. It appears that there is a higher proportion of Romance words in Macaulay which reflects itself in the alphabetical distribution.

Finally, Mr. Yule comes to the question which originally led him to the whole inquiry, whether there is anything in the vocabularies of the acknowledged works of à Kempis and Gerson which throws light on rival claims of the two men to authorship of the "Imitatio". He concludes, after a thorough examination, that Gerson is a most unlikely candidate, whereas Thomas could quite well have been the author. This confirms the evidence provided by distributions of sentence lengths. To me the evidence against Gerson appears quite decisive.

Readers who are unfamiliar with statistical methods need not be deterred from studying this book. Mr. Yule allows himself whatever technique he requires to solve his problems; but, in fact, that technique is not very elaborate and is accompanied by simple explanations which will smooth the way for anyone who is not afraid of an occasional algebraic symbol. The whole work exhibits all those qualities which have made its author celebrated among his fellows. There is the same accuracy of detail, the same careful examination of all the pitfalls, the same cautious but steady advance into unknown territory, the same flashes of insight, the same experimental testing of every link in the chain of reasoning, the same care to make the author's meaning quite clear.

To statisticians the book will be of interest not merely because it throws up all sorts of problems for their consideration, but also as an account of a model investigation in a new and difficult field. To anyone, statistician or not, who takes an interest in the languages which he learns and uses, the book will present many new points of view on a fascinating subject, and much definite information about matters which have hitherto been studied in a vague and intuitive way. M. G. Kendall.

THE AFFINE CONNEXION IN PHYSICAL FIELD THEORIES

By PROF. E. SCHROEDINGER
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1. The loss of connexion by general invariance. The essential physical entities are mathematically described as *invariants, vectors, tensors*. That comes from the isotropy and homogeneity of space in Euclidean geometry—or from the pseudo-isotropy of space-time, in the Restricted Theory of Relativity. When the latter is replaced by the idea of *general* invariance, that is, by regarding the three space-co-ordinates and the time only as continuous labels of the world points, which labels may equivalently be replaced by any quadruplet of continuous functions of themselves, the notion of vector or tensor subsists, but any such entity is now necessarily bound to a given world-point, it is 'a tensor at P'. For example, the *displacement*-vector, dx_k, leading from a world-point P with co-ordinates x_k (that is, x_1, x_2, x_3, x_4) to a neighbouring point Q with co-ordinates $x_k + dx_k$, is the prototype of a contravariant vector A^k at P. If you change the labels (that is to say, if you execute a general transformation of the frame) the A^k transform *by definition* as the dx_k, thus* :

$$d\hat{x}_k = \frac{\partial \hat{x}_k}{\partial x_l}\, dx_l \text{ and } \hat{A}^k = \frac{\partial \hat{x}_k}{\partial x_l}\, A^l. \qquad (1)$$

This rule is obviously inherent in the world point P, because the partial derivatives which form the coefficients *vary* from point to point. In consequence of this, you cannot directly compare a 'vector at P' with a similar 'vector at Q', even when Q is an infinitely neighbouring point.

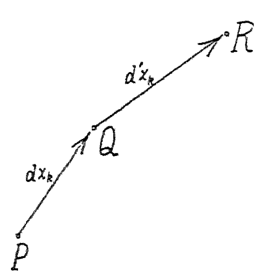

FIG. 1.

For example (see Fig. 1), on proceeding first from P to Q by dx_k, then from Q to R by $d'x_k$, you cannot tell whether the second step is *equal* in direction and length to the first one or not. The bare notion of continuity tells you, of course, that, to indicate *equality*, the $d'x_k$ have to be *very nearly* the same as the dx_k, they must not differ by more than second-order quantities. But within this margin there is no distinction. You cannot tell whether you are moving along a straight line or along a circle, whether in uniform, retarded or accelerated steps. *You have lost the connexion between neighbouring points.* You could no longer, or only in a very restricted way†, set up differential equations to control geometrical or physical *fields*.

* The sum from 1 to 4 always to be taken for an index occurring twice in the same term (as the l in (1)).

† Certain derivatives and combinations of derivatives (H. Weyl[2] calls them "linear fields") do retain a meaning even in a non-connected manifold; for example, the *gradient* of a scalar or the *curl* of a covariant vector.

2. General affine connexion. To recover this possibility you must reinstate a *connexion*. You must reintroduce some principle to replace the trivial principle of Euclidean geometry: two vectors are equal when their components are equal, quite irrespective of their association with points of the manifold.

What you want to know, or rather, what you want to 'state by decree' in an invariant manner, is *which* vector at the neighbouring point Q $(x_k + dx_k)$ is to be considered the *same* as a given vector A^k at $P(x_k)$.

The components of that "vector at Q" must differ but infinitesimally from the A^k, and so we suitably term them $A^k + \delta A^k$. The simplest and most straightforward, and at the same time a fairly general way of making the required 'decree', is to demand that the δA^k shall be some bilinear functions of the dx_k and of the A^k, thus :

$$\delta A^k = -\,\Gamma_{ml}{}^k\, A^m dx_l, \qquad (2)$$

the $\Gamma_{ml}{}^k$ being 64 coefficients, which can vary arbitrarily from world-point to world-point, that is, they are arbitrary continuous functions of the x_k (the minus sign in (2) is conventional).

If we adopt (2) without any further restrictions on the Γ's, we say we impose (the most general form of) an *affine connexion* or an 'affinity' on our continuum. The Γ's are called the components of the affine connexion. Formula (2) is said to determine 'parallel displacement' according to this affine connexion. This name is objectionable in both its terms. The Euclidean analogue is not 'parallelism' but 'sameness'; moreover, the word 'displacement', used before for the little vector with components dx_k itself, now indicates the act of transferring the vector A^m along dx_l. For clearness and brevity, I shall refer to the parallel displacement just as 'the transfer'.

Equation (2) and the notions introduced with regard to it are common to all (generally invariant) field theories. But various theories differ widely as to the way in which the affine connexion is introduced (see Sect. 4 and 5 below).

3. Curvature. Common to all theories is also the basic notion of *curvature*, which results from the affine connexion as follows. The notion of 'sameness', referring to neighbouring points, can *not* in general be extended, by continuous transfer along a curve, to world points finitely apart from one another. The transfer of a vector A^k from P to the distant point Q along a given curve C *is*, of course, unique and reversible; that is, on transferring back along the *same* curve you get back the initial vector at P. But the transfer along some other curve C' would lead to another vector at Q. Alternatively, if you transfer A^k from P to Q along C, then back to P along C', you obtain at P a vector different *in direction and length* from the original A^k.

In the complicated case under consideration (*four* dimensions; *general* affinity) it is scarcely possible to grasp intuitively this interesting behaviour, which is attributed to the *curvature* the continuum possesses in virtue of the affine connexion we have impressed on it.

Mathematically, the curvature is described by a fairly complicated entity, the Riemann-Christoffel curvature tensor $B^i{}_{k,lm}$, which is *always* antisymmetric in l, m, but has in general no other symmetry properties. It has therefore, in the general case, $4 \times 4 \times 6 = 96$ independent components. It is generally believed that this tensor is fundamental in

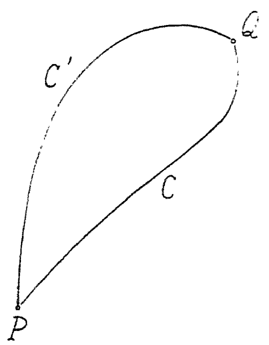

FIG. 2.

field-theory, but that it enters only in the form of its 'contractions', of which there are, in general, two*, namely, $B^m{}_{k.lm}$ and $B^k{}_{k,lm}$. We shall have to speak of them later.

4. The affinity resulting from Riemannian metric. Now let us turn to the widely different manners in which various theories introduce the affine connexion $\Gamma_{ml}{}^k$.

Einstein's[1] theory of gravitation is based on Riemannian metric, and the affine connexion results from the metric as a secondary item thus. By introducing the invariant line-element

$$ds^2 = g_{ik}\, dx_i\, dx_k, \tag{3}$$

you associate with *any* contravariant vector A^k its *invariant*

$$g_{ik}\, A^i A^k \tag{4}$$

('square of the length'). The required *correspondence* between the vectors A^k at P and $A'^k(= A^k + \delta A^k)$ at the neighbouring point Q can then be set up by adopting the following *four* rules :

(i) The invariants (4) of corresponding vectors shall be equal.

(ii) If A' and B' correspond to A and B respectively, then $A' + \lambda B'$ (where λ is any numerical constant) shall correspond to $A + \lambda B$.

(iii) The δA^k shall be linear functions of the dx_l.

The adoption of these three rules entails the general form (2) for the δA^k. We add a fourth :

(iv) The $\Gamma_{ml}{}^k$ shall be symmetric in m and l, that is, it shall equal $\Gamma_{lm}{}^k$.

The Γ's which result from these four assumptions are the so-called Christoffel-brackets, $\left\{ {k \atop lm} \right\}$, functions of the g_{ik} and their first derivatives, linear in the latter. We do not need their explicit expressions here.

5. Weyl's Theory and Eddington's point of view. H. Weyl[2] in his famous theory of 1918, the first to account for gravitation *and* electromagnetism, dropped the *first* of the above postulates and replaced it by the following :

(i') The invariants of corresponding vectors shall bear a constant ratio to one another, depending only on the two points P and Q. (Of course, this 'gauging ratio' can differ only infinitesimally from unity.)

The underlying idea was that one ought not to admit the physical possibility of comparing 'lengths' at distant world points, as Einstein's theory did indeed admit. Weyl's modification automatically introduces, in addition to the 'metrical tensor' g_{ik}, a 'metrical vector' φ_k of equally fundamental standing with g_{ik}, and capable of being interpreted as the electromagnetic potential. For the Γ's you now no longer get just the $\left\{ {k \atop ml} \right\}$, but

$$\Gamma_{ml}{}^k = \left\{ {k \atop ml} \right\} - \tfrac{1}{2} g_{ml}\, \varphi^k + \tfrac{1}{2}\delta_m{}^k \varphi_l + \tfrac{1}{2}\delta_l{}^k \varphi_m. \tag{5}$$

Sir Arthur Eddington[3], in what he modestly termed a generalization of Weyl's theory, was actually the first to take an entirely different attitude of great significance for the progress of the subject. The general affine connexion (2) is adopted *immediately* (only with the symmetry restriction $\Gamma_{ml}{}^k = \Gamma_{lm}{}^k$, which reduces the number of Γ's from 64 to 40). *Metric is made a secondary item.* To appreciate the superiority of this attitude we observe the following.

6. The restrictive Hamiltonian principle. A connected manifold of any type is not yet a field theory. To make it that, you have to impose on its basic geometrical field-quantities—the g_{ik} or the g_{ik} and φ_k or the $\Gamma_{ml}{}^k$, as the case may be—certain restrictions, differential equations. One wishes them to flow from some general principle which leaves as little arbitrariness as possible. Now almost every kind of restriction contemplated hitherto has turned out to be equivalent to a *Hamiltonian principle*, demanding that the space-time integral of an invariant density $\mathfrak{L}$, taken over any fixed region, be *stationary* :

$$\delta \int \mathfrak{L}\, dx_1\, dx_2\, dx_3\, dx_4 = 0. \tag{6}$$

This very convenient way of searching for the 'right' field-equations (you just have to search for 'the right $\mathfrak{L}$') has been widely adopted, and there are general reasons for believing that it is justified. (*If the field equations amount to a Hamiltonian principle, the conservation laws are an automatic consequence of the general invariance.*)

7. The superiority of the affine point of view. Now if our manifold carries an affine connexion, but *no* metric, the requirement that $\mathfrak{L}$ be an *invariant density* narrows the choice considerably. For the only simple *tensors* indicated by the affinity are in this case the Riemann-Christoffel tensor $B^i{}_{k,lm}$ and its contractions, mentioned before. The latter are *covariant tensors of the 2nd rank*. They cannot be contracted a second time to form an invariant, because we have no metric and thus no means of raising and lowering indices. If we exclude the B-tensor itself as 'too complicated', then to get an *invariant density* there seems to be no other means but to avail oneself of the fortunate fact that the square-root of the determinant of any covariant 2nd rank tensor *is* one.

On the other hand, if the basic geometrical field-quantities include a metrical tensor g_{ik}, you can raise and lower indices to your heart's desire and you can turn every *invariant* into a *density* by multiplying it by $\sqrt{-g}$—in a word, the choice for $\mathfrak{L}$ is then well-nigh unlimited.

Eddington[3] was the first to point to the somewhat unique possibility of taking for $\mathfrak{L}$ the square-root of the determinant of the 2nd rank curvature tensor. Einstein[4], early in 1923, worked it out more fully. Both of them were ultimately inclined to think that it led to a discouraging dilemma. You were either confronted with a serious quantitative contradiction

* See the first footnote to Sect. 1. Contraction is only admissible between one upper and one lower index.

of facts, or you had to modify the original simple idea to such an extent that the multitude of possibilities for £, expelled by the front-gate, crept in by the back-door, and rendered the whole enterprise extremely unsatisfactory.

Recent attempts in the same direction take a less pessimistic view. But before speaking of them, we must supplement the "general picture of a field theory" at one point.

8. The problem of identification. When a system of geometrical field-equations has tentatively been established in the way sketched above, the field components which they connect (which are either the original basic geometrical field-quantities or, more often, vectors and tensors built up from them) have to be *identified*, one by one, with the components of the known physical vectors and tensors, connected by more or less well-known *physical* field equations. Now, this business of identification is not so unambiguous and trivial as might be believed on considering that, after all, *gravitation* must be described by a symmetrical g_{ik}-tensor with 10 components, *electromagnetism* by an antisymmetric tensor (6-vector), governed by Einstein's and Maxwell's equations respectively. That does not seem to leave much opportunity for making mistakes in associating geometrical and physical entities.

But even so, the allotment of roles to the single components must be carefully considered. Physicists have got the habit of associating the *electric* field, with the time-spatial components of a 6-vector (that is, with the subscripts (14), (24), (34)) and the magnetic field with the space-spatial ones ((23), (31), (12)). If you are not alive to the fact (pointed out by Einstein[5]) that this is nothing but a habit, and that the converse association is, *a priori*, at least equally admissible, nay even preferable, you may easily reject a field-theory which is powerful enough to include 'sources'; reject it on the ground that it ostensibly produces them 'in the wrong place' (that is, that it exhibits *magnetic* charges and currents instead of *electric* ones, as are observed).

9. The meson-field. Of even greater moment is the following. Recent research on cosmic rays and nuclear structure leave no doubt that a *third* field exists, of equally fundamental standing with gravitation and electromagnetism: the *mesonic* field, responsible for nuclear binding. To-day no field-theory which does not embrace at least this *triad* can be deemed at all satisfactory.

Now the description of the mesonic field includes (or perhaps just consists of) a 6-vector-field governed by equations, of which Maxwell's are a special case. In fact, the two cases differ classically* only by the numerical value of *one* physical constant, the rest-mass, which is very small, possibly zero, for the 'photon', but very much non-zero for the 'meson'. Quantitatively the difference is enormous. It restricts the *range* of mesonic force to 10^{-13} cm., while electromagnetic force certainly extends[6] beyond 20,000 miles from its source and possibly throughout the universe. But general geometrical field theory, by its very nature, does not prejudice the numerical value of any universal constant. Hence very careful consideration is required here to avoid mistakes.

10. The author's recent attempt. We are now in the position to report succinctly on a recent attempt[7] for which I am responsible. The attitude is exactly the same as that described before as taken by Eddington[3] and Einstein[4] around 1923, namely, the affine connexion (2) is adopted as a primitive notion; the field-equations flow from a Hamiltonian principle, whose Lagrangian density £ is allowed to depend only on the contracted curvature tensor (or *tensors*, see below).

Hence there is no question of a 'new' theory. Yet progress is scored in *two* directions, namely, (i) in freeing oneself, for all general purposes, from the special choice of the Lagrangian £ and (ii) in accomplishing the union of the *three* fundamental fields and, at least, preparing their correct identification.

11. Unspecified Lagrangian. The freedom referred to in (i) above rests on *two* pillars, the first of which is the conviction, gained from other modern research[8], that the fundamental description of, for example, the electromagnetic field, must not be expected to involve just *one* six-vector (usually called B,E) but a second, sort of conjugate, six-vector (usually called H,D) whose components are the partial derivatives of the Lagrange function £ with respect to the components of B,E. From this point of view the field equations can be regarded as provisionally satisfactory even though they still contain those derivatives, and even before the exact functional form of the latter has been made out by deciding upon a special Lagrangian. To make the point clearer: we accept

$$\begin{aligned} \operatorname{curl} E + \dot{B} &= 0 \qquad & \operatorname{div} B &= 0 \\ \operatorname{curl} H - \dot{D} &= 0 \qquad & \operatorname{div} D &= 0 \end{aligned} \qquad (7)$$

as Maxwell's equations, without bothering at first what functions exactly H and D are of B and E.

This attitude cannot be extended to the *gravitational* field, because in this case the physical nature of the two sorts of conjugate tensors is completely known, namely, the *gravitational potential* g_{ik} and the *tensor of gravitating matter* (usually called T_{ik}). The question is, precisely, whether every field other than gravitation gives its expected 'correct' contribution to the matter tensor. We cannot even be provisionally satisfied, before ascertaining that they all do.

This gap is filled by the "second pillar", consisting of 16 *simple identities* between £ and its partial derivatives. These valuable identities flow merely from general invariance, namely, from the trivial demand that the transformational behaviour as a *scalar density* must be forced upon £, when the tensor components of which £ is a function are transformed in *their* way. As I said, these identities fill the gap, they secure that every other field contributes its due share to gravitating matter, whatever £ may be. (This is a special case of the general rule mentioned before, namely, that the conservation laws always follow directly from invariance.)

12. The tensors engendered by the curvature tensor. It is a great relief not to have to decide at an early stage upon the choice of £, when pursuing the second task, the union of the three fundamental fields. To explain the latter we must enter more closely into the tensors on which £ depends, the *contractions* of $B^{i}{}_{k,lm}$.

* At the back of our striving for a unitary field theory, the great problem awaits us of bringing it into line with quantum theory. This point is still covered with deep mist. The present article does not touch on it and has therefore to ignore such features in the conventional description of the physical fields as are concerned with their quantum character; for example, *complex* field variables, the *operators* of spin and isotopic spin, etc.

As mentioned earlier, there are two of them, namely,

$$B^m{}_{k,lm} \text{ and } B^k{}_{k,lm}.$$

The first is termed the 'Einstein-tensor'. It has in general no symmetry and thus splits up into the sum of a symmetrical tensor and a skew-symmetrical tensor (a 6-vector). The second contraction, $B^k{}_{k,lm}$, is always a 6-vector.

We are thus faced with, altogether, one symmetrical tensor of ten components and two 6-vectors—*in admirable agreement with the physicist's desire, who wishes to account for gravitation, electromagnetism and the meson-field.*

But it must be noted that one or the other of these three tensors may be quenched as an independent entity by the special choice of the affine connexion.

In the affine connexion customarily derived from Riemannian metric ($\Gamma^k{}_{ml} = \left\{ \begin{matrix} k \\ lm \end{matrix} \right\}$), *both 6-vectors vanish*. That is why Einstein's theory of gravitation[1] can account for *nothing but gravitation*.

In any *symmetrical* affine connexion ($\Gamma_{ml}{}^k = \Gamma_{lm}{}^k$) the two 6-vectors *coincide* and thus count only as one. That is why the symmetry condition was, with few exceptions[5], adhered to so long as the meson field and its fundamental nature remained unknown.

13. The union of the three fundamental fields. In pursuing the non-symmetric case (though not yet the completely general one) I have reached, along the lines described above, a fully satisfactory unified description of gravitation, electromagnetism and a 6-vectorial meson[7]. The work is far from completed. The completely general case must be tackled, and eventually, of course, the possible special choices for $\mathfrak{L}$ must be examined on their merits. But one point concerning *identification* deserves to be mentioned now.

That 6-vector field which is already obtained with a *symmetrical* connexion and which in all previous attempts was, naturally, identified with electromagnetism, is actually capable of representing either electromagnetism or the meson, according to what value is given to the rest-mass.

The *second* 6-vector field, the one that turns up on dropping the symmetry condition, does not seem to have this equivocal character. It can only be electromagnetism; and that would mean, only it can be electromagnetism.

This means that the meson-field would appear to be an even more fundamental phenomenon than electromagnetism; and that it is even more intimately akin to gravitation, its cousin, as it were. This is just what one would expect, since for all that we know, the mesonic field is produced universally by all gravitating matter, irrespective of its electric charge; whereas the latter is in no recognizable relation to the mass.

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INCOMPATIBILITY IN PLANTS

ITS GENETICAL AND PHYSIOLOGICAL SYNTHESIS

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SEXUAL reproduction is essentially the formation of a new individual resulting from the fusion of two gametic nuclei. Any hindrance to this fusion, within the regular mating group, except when it is due to a defect in the nuclei themselves, is said to be due to incompatibility. In many fungi the cells carrying the nuclei are undifferentiated: they are hyphal cells which, when growing together, fuse and transfer nuclei from one to another. In flowering plants, the cells containing the nuclei are differentiated into the male pollen grain and the female egg-cell. The pollen grain is carried to the stigma by wind or insects, and in this position it produces a pollen tube which grows down the style, penetrates the egg-cell and discharges the male nuclei, so that they can fuse with their female partners. Breeding experiments have shown that incompatibility is: (1) always genetically determined, and (2) that it acts to prevent the fusion of nuclei from closely related parents. It is a limiting mechanism which takes many forms both genetically and physiologically. An examination of the meaning and relationship of these forms not only gives a clue to their evolution but also to the action of the genes controlling them.

For the present purpose, incompatibility in flowering plants can be provisionally classified into two systems:

(1) *Incompatibility without heterostyly*, that is, without any floral morphological differences. (2) *Incompatibility with heterostyly*, that is, differentiation into long- and short-styled plants. Self- and cross-pollination within these long- and short-styled plants are incompatible, while pollinations between them are compatible.

The biological efficiency of these breeding control systems has been discussed by Dr. K. Mather[1], and he has concluded that the intervention of diploid tissue, in the form of a style, between the pollen and eggs in flowering plants results in greater efficiency than when this is lacking, as in the fungi. The two systems in flowering plants, that is, with and without heterostyly, appear, however, to have a similar net advantage for the breeding control, although there are slight differences, such as in the amount of sister mating that is permitted by the two systems. The physiology and chemistry of these systems may help to explain the special advantages of one or the other.

Consider first the fungi. The genetical control of incompatibility ('heterothally') in many fungi is based on one or two major genes, each gene having a large number of multiple alleles[2]. This number, as in plants without heterostyly, cannot be matched or even approached by any other series of multiple alleles in plants or animals. Physiologically, two types of incompatibility can be distinguished. In the most common type the hyphæ of the two haploid mycelia, although incompatible because they have one or more incompatibility alleles in common, may grow together and some hyphal fusion may occur. A transference of nuclei may follow; but the nuclei fail to make co-ordinated divisions and thus fail to establish a diplophase mycelium which is essential for spore formation. Furthermore, when a diplophase mycelium is mated with a haploid mycelium, the two nuclei in

the diplophase are quite independent in their reactions to the nucleus of the haploid mycelium[2]. The reaction is therefore one between haploid nuclei.

The less common type of incompatibility in fungi is called hyphal aversion. Here the hyphæ of certain incompatible strains grow towards each other until they are 3–5 mm. apart. At this point they stop growing or grow in the reverse direction. Aerial hyphæ show aversion quite as strongly as hyphæ growing in the culture medium. According to Vandendries[3] the aversion is prevented when metal strips are placed between the averting strains, but strips of glass and mica have no such effect.

Incompatibility without Heterostyly

In diploid flowering plants, the incompatibility reaction is one between haploid pollen grains and diploid stylar and ovarian tissue. The genetical control of this reaction in plants without heterostyly is based on one major gene having a large number of multiple alleles. These are usually designated S_1, $S_2 \ldots S_k$. The pollen reaction, in contrast to that in heterostyly, is under the control of the one S allele in the pollen grain and not of the two S alleles in the soma from which it originates. These S alleles have the action of inhibiting pollen-tube growth in any style that has the same S allele as the pollen grains. For example, S_1 pollen will not grow in a style carrying S_1, but it will grow in all other styles. When compatible and incompatible pollen-tubes grow side by side in the same style, they exert no influence on each other, thus showing that the inhibition is specific to each pollen-tube. The inhibition may sometimes be accompanied by a swelling of the tube end and a thickening of the cell wall, and occasionally by the tube ends becoming surrounded by a diffuse matter with a similar staining reaction to the pollen cytoplasm, although the tube ends show no sign of rupture. These changes are, however, probably secondary effects and not the cause of inhibition, since they do not occur in all cases.

The time and place of inhibition in the style varies according to the species[4]. In *Raphanus sativus* and *Brassica oleracea* germination is affected, in *Oenothera organensis* the tubes stop growing before they have travelled one tenth of their normal distance[5], in *Prunus avium* inhibition is at half way down the style, while in Pyrus and Nemesia it is within the ovarian cavity. Does this mean that the incompatibility activity of the style is localized? This is certainly true for the stigmatic cells of Brassica, since cutting them away removes the inhibition and complete fertility results[6,4]; but this is an exceptional refinement which has not been evolved in other species. Thus, in some species, grafting at different levels two styles, one compatible and the other incompatible with the test pollen, has shown that any part of the style is equally effective in inhibiting pollen-tube growth[7]. Furthermore, the place at which pollen-tube growth stops in the style is affected by temperaure[8]. In all species which have been tested, although compatible tube-growth is accelerated by a rise in temperature, incompatible tube growth is stopped in a shorter time at 25–30° C. than at lower temperatures (10°). This reduction is due both to slower growth and to an earlier stoppage of growth.

Thus it seems that: (1) incompatibility is the result of a reaction between any part of the style or ovarian tissue and the pollen grain or tube; (2) the rate of the reaction is greater at higher temperatures; (3) the products of the reaction accumulate during tube growth causing a lower growth-rate, and finally when a threshold concentration has been reached, complete inhibition.

Diploid styles carry two different S alleles, and just as the reaction of incompatible tubes are independent of one another, these two S alleles in the style are independent in their action on the pollen tubes. This independence, that is, lack of dominance or overriding effect of one allele on another, is also strikingly shown in autotetraploids in which two, three or even four different S alleles can be present. Each allele still exerts its specific effect. For example, a tetraploid style of the constitution $S_1S_2S_3S_4$ rejects pollen carrying any one of these alleles, but all other pollen is compatible[14]. Hence reciprocal crosses between tetraploids and diploids often show differences. For example, the cross $S_1S_2S_3S_4 \times S_1S_2$ is incompatible, S_3 and S_4 alleles in the style having no weakening effect on the reaction of the other alleles; but $S_1S_2 \times S_1S_2S_3S_4$ is compatible, S_3S_4 pollen functioning in an S_1S_2 style. The independence is emphasized by the action of self-fertility (S_F) alleles of the same gene. In Nicotiana, pollen carrying S_F is effective on any style, but an S_FS_1 style will not accept S_1 pollen although all other pollen is acceptable[9]. In *Trifolium repens*, however, the S_F allele appears to have some overriding effect on the normal allele in the style[10].

The significance of this independent action will be referred to later, but one point will be made now. The existence of two independent S alleles in the style implies that the physiological mechanism depends on highly specific and independent reactions, such as are characteristic of protein molecules. Clearly, merely quantitative differences in conditions such as osmotic pressure or pH could not be effective in doing this, because two different osmotic pressures or pH values in the diploid, and four in the tetraploid, would be required in each cell of the style to give the reactions produced by the two or four S alleles.

Pollen grains of diploid plants carry only one S allele, thus interaction of these alleles within pollen grains does not arise; but in the pollen of autotetraploids, of which many new types are now available for experiment, we have the possibility of gene interaction.

Autotetraploids of *Pyrus communis*[11], Petunia species[12] and three Solanum species[13] are fully self-compatible, although the diploids from which they arose are self-incompatible. *Oenothera organensis* is partially self-compatible in the tetraploid form. From the analysis of this effect in *Pyrus* and *Oenothera* it appears that pollen grains which carry two different S alleles are compatible in a style carrying both these alleles[14].

For example, an $S_1S_1S_2S_2$ plant is self-compatible and the pollen segregates both compatible and incompatible grains. It appears that the compatible grains are S_1S_2 and the incompatible grains are S_1S_1 and S_2S_2. Thus the normal action of S_1 and S_2 in the pollen has been suppressed by their interaction. The contrast between the pollen grain and the style in regard to gene interaction is summarized in Table 1.

In the interpretation of Table 1 it should be said that the tetraploids are of recent origin, and therefore have not been subject to natural selection. Natural selection in the diploid has produced independent gene action in the style, an effect which is maintained in the tetraploids. In the pollen grains of

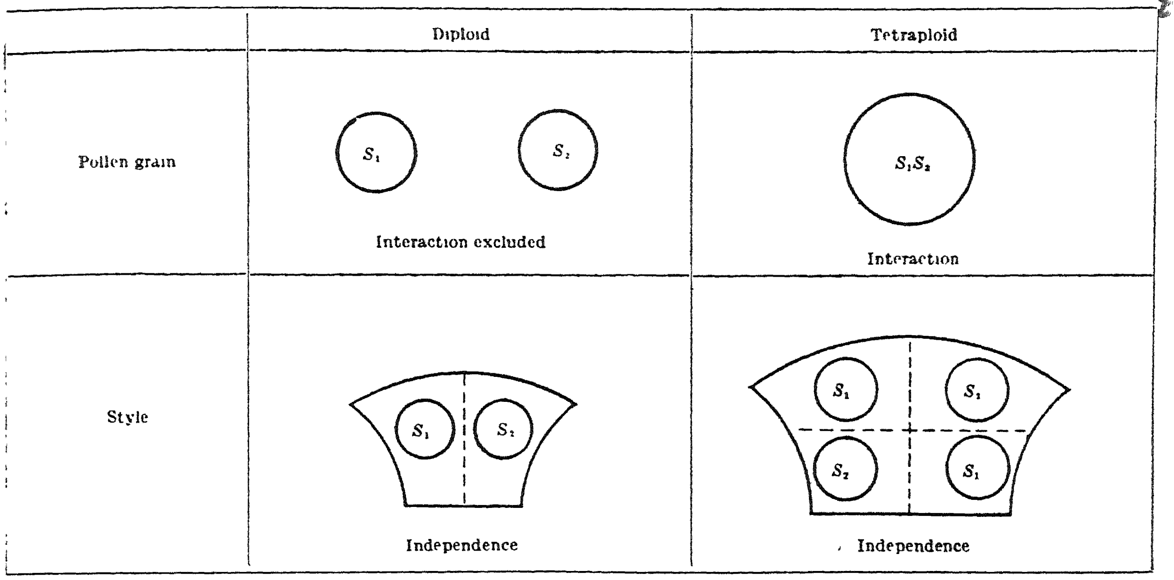

TABLE 1. INTERACTION AND INDEPENDENCE OF S ALLELES, SHOWING THAT TETRAPLOIDY HAS A DIFFERENT EFFECT IN THE POLLEN THAN IN THE STYLE. NATURAL SELECTION HAS BEEN OPERATING IN THE STYLE OF THE DIPLOID, BUT NOT IN THE POLLEN; THIS IS APPARENT ONLY WHEN THERE ARE 2 ALLELES IN THE POLLEN GRAIN.

diploids, although independence is necessary for the system, natural selection has not been operating to produce this effect, since only one allele is present. Hence in the tetraploid gene interaction occurs and the incompatibility system is, in consequence, mainly ineffective.

Incompatibility with Heterostyly

The genetical control of incompatibility in heterostyled plants is based on one gene in distyly and on two genes in tristyly, each gene having two alleles. The pollen reaction is controlled by the diploid soma from which it originates.

Pollen tubes have been examined in three species. In two of these, *Primula obconica* and *P. sinensis*[8], the kind of inhibition of the pollen tubes and the effect of temperature are similar to those in plants without heterostyly. In the third species, *Linum grandiflorum*[15], osmotic pressure differences are the main agent of incompatibility. The osmotic pressure of the style is equivalent to a 20 per cent sucrose solution in the long-styled plants and to a 12 per cent solution in the short-styled plants. The values for the pollen grains are: long-styled plants 50 per cent, short-styled plants 80 per cent. Thus the higher osmotic pressure of the pollen of short-styled plants is suited to the higher osmotic pressure of the long style. The osmotic pressure differences, in the form

TABLE 2. SHOWING THE DEPENDENCE OF POLLEN BEHAVIOUR ON THE OSMOTIC PRESSURE RATIOS OF POLLEN : STYLE IN *Linum grandiflorum*.

		Pollen	
		Long	Short
Style	Long	2·5 : 1 No germination or swelling	4 : 1 Normal pollen-tube growth
	Short	4 : 1 Normal pollen-tube growth	7 : 1 Pollen tubes burst

of a ratio of pollen : style, and the pollen behaviour are given in Table 2.

Both compatible pollinations, long × short and short × long, have a pollen to style ratio of 4 : 1, and here the pollen-tube growth is normal. In the incompatible pollinations, the ratio differs from the 4 : 1 ratio, and this affects the pollen-tube growth in a way which is not found in other incompatible species. Furthermore, temperature has no effect on the incompatible pollen behaviour.

This osmotic mechanism is clearly different in principle from the one in Primula species and in plants without heterostyly, in which differences of osmotic pressure have not been found. It is a mechanism which could be associated only with the genetical control characteristic of heterostyly. The other one, in Primula, may well be analogous to that operating in plants without heterostyly. That two different physiological mechanisms exist among heterostyled species shows that the limitation imposed by the genetical control is less severe in these species than in species without heterostyly.

In fungi we do not yet know enough, but in the two types of flowering plants we can now compare the genetical and the physiological control.

Let us first consider the genetical control. We have seen that haploid control of the pollen reaction, independent action of the S alleles in the style and a large multiple allele series are characteristic of the system in plants without heterostyly; while diploid control of the pollen reaction, interaction with dominance of S alleles in the style and two alleles of one or two genes are always associated in heterostyly. The probable explanation for these associations lies in the adaptive control of gene action and interaction. With diploid control of the pollen and dominance in the style, any effective new mutation of the S gene must not only produce a new type of style-and-pollen reaction but must also have its dominance relations with the other alleles selectively balanced. In these cases a large multiple allele series is therefore very improbable. With haploid control

of the pollen and with gene independence in the style no difficulties of dominance arise, and any new mutation will be at an immediate advantage since it will give compatibility with all others.

It might be argued that the morphological difference in heterostyled plants is the chief restriction on the number of incompatibility alleles; but the answer to this is found in *Capsella grandiflora*[16], which is a species without heterostyly and with all the genetical characteristics of the heterostyled system.

Hypothetical systems constructed with the elements of both the known systems differently combined show that correct adjustment cannot be obtained in another way. For example, a system with haploid control of the pollen, and dominance of *S* alleles in the style will fail, because an *Ss* plant will be self-compatible since the *s* pollen would grow in an *Ss* style. Also in an *ss* × *Ss* pollination only *S* pollen would be compatible. Such a system has so many faults that it could not last long if it ever arose. The reverse of this, that is, diploid control of the pollen and independence of *S* alleles in the style, has the fault that *Ss* styles will reject the pollen of both *Ss* and *ss* plants. It is true that with three or more alleles and special dominance relations between them a perpetuating system can be imagined; but this involves such unusual properties of the gene that it can be disregarded.

TABLE 3. A SUMMARY OF THE GENETICAL AND PHYSIOLOGICAL CONTROL OF INCOMPATIBILITY SHOWING THE RELATIONSHIP BETWEEN THEM.

Morphology	Species	Physiology	Genetics
Not heterostyled	*Oenothera organensis* *Prunus avium* *Nicotiana sanderæ*	(1) Independent gene action in the style but not in the pollen (2) Haploid pollen control (3) No dominance (4) Protein reactions	One gene Multiple alleles
	Capsella grandiflora	(1) Co-ordinated gene action in style and pollen (2) Diploid pollen control (3) Dominance (4) (*a*) Protein reactions (*b*) Osmotic pressure	1–2 genes 2 alleles
Heterostyled	*Primula obconica* *Primula sinensis* *Linum grandiflorum*		

In their physiological control of incompatibility, plants without heterostyly and heterostyled plants differ in a way which reflects the genetical differences. This relationship is summarized in Table 3. Only one mechanism has been found in plants without heterostyly, and this appears to be an immunity type of reaction between specific proteins of the pollen and style. This alone has the possibility of variation necessary to meet the requirements of a large multiple allele series and the specificity necessary for the independent gene action in the style. In heterostyly it appears that this type of reaction is also present in some species; but another mechanism based on osmotic pressure has been found in Linum, and from the genetical evidence there is reason to believe that others exist. Thus a variety of different combinations of physiological and genetical mechanisms have been appropriately combined by selection, in favouring outbreeding modifications of the genetic system which have a long-term evolutionary advantage.

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FACTORS IN THE PRODUCTION OF HONEY

By E. B. WEDMORE, C.B.E.

MR. JOHN PRYCE-JONES, who is a physical chemist, discusses "Some Problems Associated with Nectar, Honey and Pollen" in forty-five pages of the *Journal of the Linnean Society* (Pt. 2, 1942–43). This critical résumé will be most valuable to future workers in the same field. A strong case can be made out for further work. The honey bee in Great Britain contributes, by its pollinating activities alone, £4,000,000 a year to the economy of fruit-growing and seed production. An annual expenditure on research of £4,000 would show a return of 10 : 1 if it only increased efficiency by one per cent per annum; incidentally, in the U.S.S.R. the figure is £40,000,000 a year.

Future investigators will need to study far more than the fifty-six principal references cited by Mr. Pryce-Jones. How hard it is to persuade experimenters that the last thing they must do is make an experiment, and the last but one is to record all the circumstances and features that may affect interpretation and application of the results! Many of the researches cited lose permanent value through failure in the latter duty. The conflicting and partial conclusions reached are faithfully dealt with by Pryce-Jones, but many are open to further criticism. For example, there is the investigator who correlates percentage of nectar in fireweed with the humidity of the atmosphere, expressing the results to four significant figures; evidently the arithmetic took charge of the investigator. Having regard to the very large variation disclosed of sugar content with humidity, the meaningless nature of figures given for sugar content without reference to humidity is at once apparent; yet the records abound with them.

Based on the capacity of the bee's honey sac, a round figure of 20,000 flights is quoted for the collection of one pound of nectar. This is converted to 80,000 for honey. Taking the sugar content of honey at 80 per cent, this puts that of the nectar at 20 per cent. Now in the first place, the bee scarcely ever arrives home with a honey sac anything like full; again, a full sac will carry nearly three times the figure quoted; and the figure of 20 per cent is near the lower limit of what interests the bee, and it will generally find a much more profitable source to work upon. It is certain that the figure of 80,000 flights is too high for profitable harvesting. Incidentally, the figure of 200 lb. given as the honey

which a colony consumes in bee production per season and for its own needs before it can show any surplus is on the low side for a really profitable colony.

Miss A. D. Betts has shown that bees can transfer a maximum amount of sugar from a feeder on the hive in a given time when the sugar content of the syrup is about 40 per cent. Thicker syrup is taken too slowly, and thinner syrup carries too little sugar. In the field, the bee spends the larger part of its time travelling to and from the source and from flower to flower. Now if the time occupied in gathering nectar is fixed as part of the whole, Miss Betts' figure is likely to apply; but I infer that for a given strength of nectar the bee will prefer the source in which the nectaries have the larger content, for she will then economize in time of travel. If, however, the sugar content of the nectars varies, it will pay the bee to work at a nectar more dense than that named provided there is more sugar in each nectary; that is, it is the sugar content rather than the nectar content of the nectary that is important and up to limits in excess of 40 per cent. In very dry weather, sugar content far exceeds any figures quoted by Pryce-Jones; indeed, a supersaturated solution is found in very dry weather. In 1942 in Kent and elsewhere, the bees could not work on the limes because the nectar was crystallized.

There is a great deal yet to be done to solve the problems associated with nectar production. No fewer than five theories are quoted and discussed; only one touches upon the relationship of sugar production to soil content; that deals with nitrogen content, but leaves potassium and phosphorus out of account. Pryce-Jones remarks that while the nectary acts as a semi-permeable membrane, holding back the proteins in the sap, no explanation has yet been offered of the diffusion of a dilute solution of sugar in the sap into a more concentrated solution in the nectary.

Pryce-Jones himself has shown that the thixotropy characterizing a very few honeys, notably that from ling and from manuka, is due to the presence of about 1 per cent of a protein. Honey usually contains but a trace of any protein. This particular protein may be extracted and when added to another and liquid honey causes it to become thixotropic. It is difficult to attach much weight to the criticism by Paul 'Espinasse that it has yet to be proved that the protein is of vegetable origin and not added by the bee. Why should all bees add so unfortunate a protein only to those particular nectars, introducing a property which may cause them later to starve in the apparent presence of plenty? It would appear to be far more probable that in these plants a small quantity of a certain protein passes through from the sap. There is room for further investigation of this protein and especially its molecular weight.

In the study of the relationship between the honey crop and the weather, much confusion has been introduced through failure to recognize the large variation of sugar content of nectar when observing changes of hive weight. Certain correlations with weather conditions, however, have been obtained. These indicate that in summer and early autumn, temperatures are generally adequate, but humidity tends to be too low; hence a wide variation in temperature with its wide variation in relative humidity tends to bring the sugar contents within the range for efficient collection for some period of the day, and perhaps to assist in nectar secretion. In the spring, however, temperatures may be inadequate, also hours of sunshine; hence greater importance is attached to temperatures and especially to temperature variation, the latter bringing about periods of suitable temperature and corresponding with periods of intermittent but more adequate sunshine. The conditions are somewhat different as between clay and sandy soils. In studying atmospheric conditions in the summer and autumn, however, there is a correlation factor above 50 per cent outstanding against unknown factors, showing the supreme importance of sources of nectar.

The bee-keeper desires a more continuous succession of adequate sources than he can yet find in any one place; also less unintentional interference by those concerned with agriculture and horticulture. Surely, having regard to the very large contribution to these industries made by the bee-keeper, referred to in the opening paragraph above, it is time that the Ministry of Agriculture assumed official responsibility for bee-keeping, and secured some correlation of the interests of these several industries. A co-operative study, for example, of the benefits to be derived by the several parties by increased use of appropriate sweet clovers, and incidentally of Zofka clover, should provide a very large return for a small expenditure by the Ministry. Any programme should be examined by practical bee-keepers and agriculturists as well as by scientific men if it is to be really effective and profitable. On the practical side, there should be no lack of assistance if only someone in authority would bring the parties together.

OBITUARIES

Dr. J. Argyll Campbell

Argyll Campbell was a most distinguished student at Edinburgh, gaining very many university prizes and honours. He unfortunately suffered early in his career a catarrhal infection which resulted in deafness, a handicap which he most bravely overcame so far as his output of research was concerned, but which prevented him gaining full recognition of his worth. As professor of physiology at the Government School of Medicine, Singapore, he did valuable work, and in the War of 1914–18 prevented the authorities from substituting an equal weight of sweet potatoes (a watery food) for rice in the workers' ration. As one of a small commission, he was largely instrumental in securing the addition of the province of Trengannu to the Malay States.

Returning to Great Britain, Campbell joined the Department of Applied Physiology at the National Institute of Medical Research, where, until ill-health led to his recent retirement, he carried out very valuable research work. An inquiry with me into the protective effect of water-proof clothing against exposure, such as results from shipwreck, resulted in the adoption by the Ministry of Transport of a suitable suit for merchant seamen in the present War; a quarter of a million such suits have been issued, and high value is given to these as the result of experience.

Campbell developed a simple method of measuring the tension of oxygen and carbon dioxide in tissue spaces, and made the interesting discovery that high pressures of oxygen, such as produce oxygen poisoning, occasion a high tension of carbon dioxide in these spaces. The power of hæmoglobin to combine with and carry carbon dioxide from the tissues is thwarted by its saturation with oxygen. He carried out most

important work on oxygen-want at high altitudes, finding that animals could not continue for long to live at altitudes above 20,000 ft. This degeneration has been fully confirmed for man by the experiences reported by Everest climbers such as Mr. Shipton. Although 27,000 ft. has been reached, the incapacity of the climbers is such that there is little hope of Everest being climbed without use of oxygen-breathing apparatus, and that use is beset with difficulties.

Campbell pointed out that one of the means of acclimatization to high altitudes was hypertrophy of the heart. His work on oxygen-want led to the contrivance of a simple but effective oxygen-breathing face mask. With the late Dr. Poulton he published a valuable book on "Oxygen and Carbon Dioxide Therapy", a standard work on the subject. Further researches showed him that oxygen-want is better resisted on a certain diet, such as one of carrots, and this inquiry led to possible means of improving the resistance of high flyers. He also found that the effects of oxygen poisoning at high pressures are warded off by a fall in body temperature; animals are more susceptible at high than at low external temperature.

With me he carried out an investigation of the washing out of nitrogen dissolved in the body by the breathing of oxygen, and the amount of nitrogen in the bone marrow of animals exposed to high air pressures—work of interest in regard to compressed-air illness.

Another important line of inquiry carried out by Campbell was on the effect of inhalation of dust on the production of pulmonary cancer. He found that tar-containing dust from roads greatly increased the frequency of such cancer in mice; dust not containing tar did so also, but to much less extent.

Whatever researches Campbell carried out, of which a few have been mentioned, were executed with the greatest accuracy and thoroughness, so that his results stand unquestioned. He was so deaf that one had to communicate with him by writing, and this fact prevented all but a few from realizing his high worth and modest character. LEONARD HILL.

Mr. E. C. Stuart Baker, C.I.E.

By the death of Mr. Stuart Baker on April 16 at the age of seventy-nine, ornithology, and especially Indian ornithology, has lost one of its most eminent exponents. He was born in 1864; after being educated at Trinity College, Stratford-on-Avon, he followed his father's career in entering the Indian Police Force in 1883. Nearly all his service was spent in Assam, then, even more so than now, a wild mountainous region peopled by primitive and savage tribes, which offered unbounded opportunities for sport and the observation of wild life, of which he took every advantage. He rose to be officiating inspector of police for the Province in 1910; in 1912 he was selected to reorganize the special police force of the Port of London Authority, a post which he held until he retired in 1925.

On his return to England Stuart Baker settled at Upper Norwood and, taking an interest in local politics, he was elected a councillor of the Croydon Town Council, where he served two terms as mayor during 1937–38.

It was not until about the time of his return from India that Stuart Baker began to publish his numerous works on Indian ornithology. These include volumes on the Indian ducks, doves and game-birds, and finally he was asked to prepare a new edition of the birds for "The Fauna of British India" series, issued under the authority of the Secretary of State for India in Council. The first edition by E. W. Oates and W. T. Blanford was in four volumes. Stuart Baker expanded these into eight, published during 1922–30, and practically rewrote the whole. It has since become the standard work on the subject. As he felt he had not done justice, for want of space, to nesting and other habits, he prepared four more volumes, "The Nidification of Birds of the Indian Empire", which appeared during 1932–35.

Perhaps Stuart Baker's most valuable work was on the cuckoo problem. Always deeply interested in the study of birds' eggs, of which he amassed a very large collection, he paid special attention to the cuckoos, especially those of the many Indian and Asiatic species. The results of these observations and reflexions appeared in 1942 under the title of "Cuckoo Problems", in which he discussed such questions as adaptation of cuckoo's eggs to those of the fosterers, how far the 'survival of the fittest' has been concerned in the evolution and adaptation of the eggs, and such lesser questions as the method by which the cuckoo egg has been introduced into the nest of the fosterer and the ejection of fosterers' eggs from the nest by the young cuckoo. The value of this work was greatly enhanced because Baker had at his disposal much evidence from the many Indian species and did not confine himself to the European cuckoo, which had been the case with most previous writers.

Stuart Baker received the C.I.E. in 1932. He was a fellow of the Linnean and Zoological Societies and a member of the British Ornithologists' Union, of which he was honorary secretary and treasurer from 19 3 until 1936.

He married in 1897 Ethel May Roffey, who survives him together with four daughters. W. L. SCLATER.

Mr. J. W. Bullerwell

JOHN WILLIAM BULLERWELL began teaching (two years before he entered college) as an assistant master at the Orphan House School, Newcastle, where he had previously been a student. While an undergraduate at Armstrong College, he taught mathematics and mechanics in Newcastle School Board evening schools, and after graduating in 1896 he became science master at St. Cuthbert's Grammar School and part-time lecturer in mathematics at Armstrong College. In 1901 he became lecturer in mathematics at Hartley College, Southampton, a post which he held only for a short time, before returning to Newcastle as lecturer in physics in 1902, becoming senior lecturer in 1919. He retired in 1938, but returned to duty again until 1942.

Two or three generations of students will remember Bullerwell for his novel and well-thought-out methods of presenting his subject. He was above all other things a teacher, whose every desire was to help and advise his students. He had no grudges against anyone, and he was always ready to rejoice in the promotions and successes of others. With his six feet four inches he commanded discipline with ease, but it was always a parental rather than a dictatorial discipline.

Bullerwell was appointed secretary of the University of Durham Schools Examination Board in 1932, and he carried out the duties with efficiency until

illness forced him to retire in 1942. He acted as treasurer of the Armstrong (later King's) College Choral and Orchestral Society for forty years and in the same capacity for the University of Durham Philosophical Society. The Newcastle Bach Choir was one of his greatest interests, and he was associated with it from the time of its foundation. For many years also he was a member of the committee of the Newcastle upon Tyne Literary and Philosophical Society. He had some reputation as a collector of North Country folk songs, and many people will have pleasant memories of his lectures on the subject.

Bullerwell died on March 17 at the age of seventy.

George W. Todd.

Prof. W. G. MacCallum

Prof. William George MacCallum, the eminent American pathologist, who died on February 3 at the age of sixty-nine, was born at Dunnville, Ontario, on April 18, 1874, the son of a medical man. After qualifying at the University of Toronto in 1894 and at the Johns Hopkins University School of Medicine in 1897, he held the post of intern and later of resident pathologist at the Johns Hopkins Hospital. In 1899 he was appointed assistant in pathology at Johns Hopkins, where he afterwards became assistant professor and professor in pathological physiology and lecturer in forensic medicine. In 1909 he was appointed professor of pathology at the Columbia University College of Physicians and Surgeons, as well as pathologist at the German Hospital and Presbyterian Hospital. In 1917 he succeeded the well-known pathologist Dr. William H. Welch as professor of pathology at Johns Hopkins, and held this appointment until the spring of 1943.

In addition to a "Text-book of Pathology", of which the first edition appeared in 1916 and the seventh and last in 1940, MacCallum's chief publications were on the sexual conjugation of the parasites of avian malaria (1897), the pathology of pneumonia following influenza in the United States during the winter of 1917–18, calcium in tetany (1918), and with Ella H. Oppenheimer "Centrafugalization, a Method for the Study of Filtrable Viruses as applied to Vaccinia". He was also the author of a biography of the surgeon W. S. Halstead.

MacCallum was well known in Great Britain, where he was elected an honorary fellow of the Royal Society of Medicine in 1934. He was also honorary fellow of the Swedish Medical Society at Stockholm, a member of the U.S. National Academy of Sciences, and of the Harvey Society, of which he was president in 1914.

J. D. Rolleston.

We regret to announce the following deaths:

Dr. J. C. Dunlop, formerly registrar-general for Scotland, and an honorary fellow of the Faculty of Actuaries of Scotland, on April 10, aged seventy-eight.

Sir Clement Hindley, K.C.I.E., member of the Advisory Council for Scientific and Industrial Research, and president in 1939 of the Institution of Civil Engineers, on May 3, aged sixty-nine.

Mr. C. B. Rickett, an authority on the birds of southern China, aged ninety-three.

Commander J. A. Slee, C.B.E., chairman in 1938 of the Wireless Section of the Institution of Electrical Engineers, aged sixty-five.

Prof. W. M. Thornton, O.B.E., emeritus professor of electrical engineering at King's College, Newcastle upon Tyne, on May 2, aged seventy-four.

NEWS and VIEWS

Water Supply in Great Britain

A White Paper on water supplies ("A National Water Policy." H.M. Stationery Office, 6*d*.) points out that the problem facing Great Britain is one of organization and distribution, not of total resources, which are ample for all needs. Since water is a bulky commodity, its costs of distribution are relatively high and therefore local sources must be used so far as possible. To do this efficiently will require, not only changes in law and practice, with the co-ordination of the many varied authorities up and down the country, but also a fuller survey of resources than is at present available, and adequate protection against pollution and waste. There must also be a satisfactory supply for industrialists and farmers, who now are normally outside the obligations of public water-undertakings. Agricultural production must no longer be hampered by insufficiency of water and haphazard dependence on casual supplies. The proposals embodied in this report are based on three principles: first, adequate control of water supply services, including changes where they can be justified by greater efficiency or reduction in costs; secondly, responsibility for water supply to rest with democratic bodies ranging from Parliament to local authorities; and thirdly, sectional interests to be subordinate to the national interest, subject to Parliamentary approval.

In the light of these principles, the main proposals of the Government are as follow: the Minister of Health and the Secretary of State for Scotland would be given the statutory duty of promoting the provision of adequate water supply and the conservation of water resources, and their policy would be based on the collection of full information regarding sources and needs. The Central Advisory Water Committee of England and Wales should be reconstituted as a statutory body, and a similar committee set up for Scotland. Survey of the needs of large areas and the efficiency of supplies should be continued, close touch being maintained with town and country planning policies. Amalgamation of water undertakings may be necessary in order to secure efficiency and economy, and also the giving of bulk supplies by one water undertaking to another. Steps must be taken to prevent misuse, waste and pollution. Industry and agriculture are to have the right to water supplies. Compulsory powers, under proper safeguards, should be granted to take water from streams. The Ministers responsible should be given powers to require information and statistics from all users of water and sinkers of wells. The White Paper also contains certain financial proposals; but its main importance is that it considers the problems of water supply on a national basis, and admits the need for rural supplies, even though urban

populations afford the most serious problems in their steadily increasing demands.

The White Paper was discussed on a motion moved by the Minister of Health, Mr. Willink, in the House of Commons on May 3. While the statement received a general welcome, there was criticism from all sides that the suggested procedure was slow and the scheme lacked boldness. Mr. Willink said that the main instrument for collecting information on the yield and quality of water resources is the Inland Water Survey, and the Government proposes to press on with it at the earliest possible date. The Central Advisory Water Committee, with new powers, would advise the Minister of Health on general policy in the light of the information provided by the Survey. As an alternative to this Central Committee, a national water board under a strong, well-qualified chairman, was suggested as a means of co-ordinating the water policy of Great Britain. Against this suggestion it was urged by the Minister of Agriculture, Mr. R. S. Hudson, that water policy touched on too many aspects of national administration, such as housing, health, drainage and agriculture, to make a national water board feasible and practicable.

Regional Organization in Australasia

THE Agreement between the Commonwealth of Australia and the New Zealand Governments signed at Canberra on January 21, 1944, has now been published (Cmd. 6513). In addition to undertaking general collaboration with regard to the location of machinery set up under international organizations such as the United Nations Relief and Rehabilitation Administration, the two countries agree to promote the establishment of a regional organization with advisory powers, which could be called the South Seas Regional Commission, on which the Governments of the United Kingdom, the United States and the French Committee of National Liberation might be represented. Such a Commission would have as its function to secure a common policy on social, economic and political development directed towards the advancement and well-being of the inhabitants themselves and, particularly, the Commission would recommend arrangements for the increasing participation of local inhabitants in administration, with a view to the ultimate attainment of self-government in the form most suited to the circumstances of the peoples concerned; arrangements for material development, including production, finance, communications and marketing; for the co-ordination of health and medical services and education; for the maintenance and improvement of labour conditions and social services as well as collaboration in economic, social, medical and anthropological research.

The publication of periodical reviews of progress in this field is also visualized, and in addition to the establishment of a regional zone of defence and of permanent machinery for collaboration and co-operation between Australia and New Zealand, the Agreement provides for joint action in support of the principles that full control of the international air trunk routes and the ownership of all aircraft and ancillary equipment should be vested in an international air transport authority operating those routes, and that the routes themselves should be specified in an international agreement. Failing such agreement the two Governments support a system of air trunk routes controlled and operated by Governments of the British Commonwealth of Nations under Government ownership.

Colonial Geological Surveys

THE function and future of the Colonial Geological Surveys formed the subject of a recent article in NATURE (153, 273; 1944), in which a discussion on the matter, held under the joint auspices of the Geological Society of London and the Institution of Mining Engineers in November last, was summarized at some length. The subject has again been dealt with in the *Bulletin of the Imperial Institute* (41, No. 4, 255; 1943), by the 'intelligence staff' of the Institute, under the heading "A Review of Geological Survey Work in the Colonies". In this article the authors refer to all the Colonies except those small islands and groups where, it is stated, the question of establishing official Surveys scarcely arises. Particulars are given separately for each Colony as to area, the years, if any, during which geological survey work has been carried out, the amounts of money expended on such work, the staffs employed and the maps that have been published. Reference is also made to the question of water-supply and to mining activities. With few exceptions, it appears that in none of the colonies was a Geological Survey established earlier than 1918. In Ceylon, a mineral survey was commenced in 1903; and in British Malaya a Geological Survey has existed for forty years, though until 1912 it employed only one geologist. In certain other Colonies short-term mineral surveys were carried out in the early years of this century by the Imperial Institute, under the auspices of the Colonial Office.

The information supplied is based on published records, and it certainly provides factual support for the views expressed at the joint meeting of the Geological Society and the Institution of Mining Engineers at their joint meeting last year. It makes it clear, in fact, that there is ample room for enlargement, and improvement in the continuity and scope, of the work of the Colonial Geological Surveys. Actually the matter is in hand, for the Secretary of State for the Colonies has appointed a panel of experts to advise him on the subject. The intention of the authors of the Imperial Institute article is to point out the desirability that a fair share of the Colonial Office grants for the extension of scientific investigation into Colonial problems should be allocated to the expansion of geological survey work. In the view of the Institute, a Geological Survey should be regarded as a public service available to the mining, agricultural and other industries; as well as for government-sponsored public works and water supply services; and also as an educational institute. The association of the Imperial Institute with the Colonial Geological Surveys is one of long standing, and the recommendations made in this article, backed by an authoritative statement of facts, should command the attention of those interested in the welfare and development of the Colonies.

Archæological Find in Kenya

DR. L. S. B. LEAKEY, honorary curator of the Coryndon Museum, who is employed in war-time duties with the C.I.D., Nairobi, has spent eighteen days leave on Site 10 at Mount Olorgasailie in Kenya, accompanied by Mrs. Leakey, Mr. A. J. Arkell, the Commissioner for Archæology in the Sudan, Miss E. Cory, Mr. F. de V. Kirk and Mr. G. Alkin. The excavations carried out showed that the surface indications noted early in 1942 had not been misleading and that the site is of outstanding importance.

The trial trenches that have been dug have revealed that the deposits consist of lake beds alternating with land surfaces. Upon four of the land surfaces—or layers—exposed, there are abundant signs of occupation by Acheulean man, and very large numbers of hand-axes, cleavers and bolas stones have been found closely associated with the fossilized remains of extinct animals. Another discovery of importance is the finding of another occupation floor that represents the first well-authenticated evidence of the existence of a flake-culture people anywhere in East Africa, in the deposits of the Middle Pleistocene. The animal fossils found include those of extinct species of elephant, hippopotamus, giraffe and rhinoceros, a baboon that was as big as a gorilla, and a pig that was as large as a present-day rhinoceros. The Kenya Government has fenced the site, and it is proposed that the various occupation floors shall be exposed and then roofed so that visitors can see the implements and fossils lying in position.

Science and the War

A symposium of papers presented at the seventy-fifth anniversary meeting of the Kansas Academy of Science on April 10, 1943, has now been reprinted (*Trans. Kansas Academy of Science*, 46) under the title "Science and the War". L. E. Cull deals with the place of food and J. H. McMillan with that of physics in the war effort. The latter points out that when Japan began hostilities, the United States had nearly two hundred physicists directing about five hundred professional physicists, investigating specific war problems. This represented about seventy-three per cent of the physicists in the United States who were judged capable and free to carry on this type of work. Both in government research laboratories and in industry there has been an acute shortage of physicists, and the programme for training war-time physicists does not appear to have been so well organized as that for research. N. P. Sherwood's paper on "Bacteriology, Medicine and the War" emphasizes the marked advance in our knowledge and resources since 1928 for dealing with wound infections, venereal disease, typhoid and tetanus, etc.

J. W. Greene, discussing "Chemistry and the War Effort", briefly reviews the familiar achievements of the chemist in such fields as explosives, synthetic rubber, plastics, fertilizers, aviation spirit, solvents, synthetic organic chemicals, etc. "The Role of Botany in War-time" is outlined by P. B. Sears, who refers to the services of botanists in camouflage work, cotton fibre problems, plant breeding and control of disease, the preparation of airfield runways with sod covers which will prevent erosion, and particularly in food production. J. C. Frye and C. P. Kaiser's paper, "Geology in the Present War", refers to the services of the geologist in meeting difficulties in the supply of strategic minerals and other raw materials, domestic water supplies, and in mapping. J. Breukelman deals with the "Relation of Zoology to the War Effort", and refers in particular to its contribution in the field of nutrition, in pest control, in jungle warfare and in the conservation of fauna. The final paper, by H. B. Reed on "Some Contributions of Psychology toward the War Effort", after referring to the neglect of psychology after 1918 by the Armed Forces, indicates the value of the psychologist in placing men in the activities for which they are best qualified and in which they may be of the greatest service to the country, in devising technique for effective training in the skills required in military work or for building up civilian and military morale and propaganda effects, in handling and dealing with children in bombed areas, and in the effective care of war orphans. A brief account of the classification work in the U.S. Army is included.

William H. Nichols Medal of the American Chemical Society : Award to Prof. C. S. Marvel

The William H. Nichols Medal for 1944 of the New York Section of the American Chemical Society has been presented to Prof. Carl Shipp Marvel for outstanding contributions to knowledge of the structure of vinyl polymers, the long-chain molecules used as rubber substitutes, in production of plastics, and as thickening and blending agents in chemical manufacturing, and for his research in the structure of sulphur dioxide – olefin polymers. Prof. Marvel is professor of organic chemistry at the University of Illinois, and president-elect of the American Chemical Society. As a graduate student at the University of Illinois, Prof. Marvel became interested during the War of 1914–18 in the development of synthetic chemicals, at a time when the United States was dependent upon Germany for many drugs and dyes. He is now recognized as one of the outstanding authorities in the United States in organic chemistry, especially in the field of polymers, and for his extensive knowledge of organic chemical reactions. He is also a leader in the development of synthetic methods for making organic compounds, and early in his career at the University of Illinois began manufacturing chemicals needed for research there and elsewhere. One contribution in this latter field was the production of pure amino-acids, which have served brilliantly in vitamin studies and determinations of essentials of diet. The amino-acids also are used for intravenous feeding of persons unable to tolerate proteins. Other work by Prof. Marvel has dealt with the relationship of hydrogen bonding and solubility behaviour, the synthesis and rearrangement of polyenes and polyines, association of free radicals, and other research fields. Prof. Marvel was born at Waynesville, Ill., on September 11, 1894, and received his bachelor of arts degree from Illinois Wesleyan University in 1915. He was a student of Dr. A. W. Homberger, Illinois Wesleyan, and of the late Prof. W. A. Noyes, at the University of Illinois. He has been associated with the editorial board of "Organic Syntheses" since 1923, and with the *Journal of Organic Chemistry* since its founding. He is a member of the National Academy of Sciences, and was chairman of Section B–3, National Defense Research Committee, during most of 1941 and 1942.

Tannic Acid and Burns

The impression that tannic acid is a safe and reliable dressing for burns is nowadays so widespread that there will be much interest in recent experimental evidence suggesting that tannic acid should be abandoned because of the risk of the damage to the liver which it may cause. S. L. Rae and A. W. Wilkinson (*The Lancet*, March 11, 1944, p. 332) studied, by the lævulose-tolerance test, the liver function of 27 children, aged twelve years or less, who had been burned or scalded. Of these children, 12, who had burns covering an average of 17 per cent of the body surface, were treated with 2 per cent gentian violet followed by silver nitrate; and 8 of them, whose burns were smaller, covering an average of 5 per cent of the body surface, were

treated with tannic acid jelly containing one part in 5,000 of merthiolate. Impairment of liver function was least in the group treated with gentian violet and silver nitrate, although the burns in this group were much larger. In a large series of children treated with silver nitrate, there was no case of the acute toxæmia which may occur after tannic acid treatment. Impairment of liver function was commonest and most severe in the group treated with tannic acid. The authors think that this agrees with clinical experience. They suggest that the merthiolate in the tannic acid jelly used may have been partly responsible for the impairment of liver function.

Seven cases with injuries covering 5 per cent of the body surface were treated with sulphacetamide paste, and these occupied an intermediate position between the groups treated with tannic acid and gentian violet – silver nitrate. The authors point out that sulphonamide drugs may be rapidly absorbed from superficial burns and may also cause liver damage; they should be used with care. Their general conclusion is that there is now sufficient clinical and experimental evidence to justify the abandonment of tannic acid as a local application for burns. R. H. Franklin (*The Practitioner*, 62, 167; 1944) also discusses the use of tannic acid and agrees that it is being largely abandoned now. Rae and Wilkinson think that coagulation treatment may save life in the early stages of very extensive superficial burns and that, from the point of view of toxic absorption, silver nitrate is probably a safe coagulant. In an annotation, *The Lancet* (March 11, 1944, p. 344) refers to other experimental work on the toxicity of tannic acid which has been done on dogs, rats and mice, and says: "There seems little doubt now about the experimental facts concerning the toxicity of tannic acid". The *British Medical Journal* (April 1) agrees and adds that, although mortality from burns has diminished since tannic acid was introduced in 1925, there is no evidence that it has "any advantage in this respect over other methods".

Classification of Diseases and Injuries

ASKED by the Ministry of Health to advise on a system for collecting and recording statistics of patients admitted to hospital, the Medical Research Council appointed a Committee on Hospital Morbidity Statistics, which has now issued "A Provisional Classification of Diseases and Injuries for Use in Compiling Morbidity Statistics" (Med. Res. Council, Special Report Series, No. 248. H.M. Stationery Office, 1944. 3*s*. net). The classification here recommended has been adopted by the Ministry of Health for the classification of all Emergency Medical Service records, and the Ministry of Pensions is also using it. It will also be used in the Regional Bureaux of Health and Sickness records which the Nuffield Provincial Hospitals Trust is establishing in some areas. It is comparable with the International List of Causes of Death and the Diagnosis Code of the United States Public Health Service, the code numbers of both of which are included. It is also comparable with the Diagnosis Codes of the Royal Navy, Army and R.A.F. Medical Services. The coding system has been planned for use with mechanical sorting, but may be used equally well with manual filing. It is not suggested that it should replace the Standard Nomenclature of Disease of the American Medical Association.

The Committee has issued this provisional scheme as a Special Report so that it may be available for as wide a trial as possible. Dr. Percy Stocks, in a brief historical introduction, reminds us that every deceased person was either a sick or an injured person and, if his illness is classified during life, it will usually be the same as the cause of death defined in the Registrar-General's Manual. But the bulk of illnesses do not lead to death, so that a classification of diseases and injuries must give greater attention to minor and disabling conditions than a classification of causes of death needs to do. It is recognized that the diagnoses of some diseases, even when they are made by experts, may not agree, so that only tentative groupings are made in some sections. In some groups (for example, heart disease) the classification has been framed with the object of getting information necessary for a better classification. The Committee hopes, indeed, that any errors, omissions or inconsistencies observed will be reported, so that they may be incorporated in a future revised edition.

Value of Human Milk

BRADFORD-HILL has pointed out in his "Principles of Medical Statistics" that bottle-fed babies are 'selected', in that some factor has determined whether or not the mother feeds her baby. Deductions as to the relative values of breast- and bottle-feeding, based on comparisons of growth and health of groups of babies fed by one or other method, are vitiated by this selection. Mr. Eric Wood points out, in an article in the *Medical Press and Circular* of February 9, that no controlled experiment has been made in which the two groups have been comparable at the start, in heredity, environment and physical conditions. Nor is this possible; for readiness to agree to give up breast-feeding would, in itself, make the 'bottle' group a selected one. In default of this possibility, Mr. Wood points out the need for much more information on the following points. (1) The effects of the mother's environment, food, etc., on the ability to suckle and on the quality and quantity of the milk. We now realize that the easy assumption that the mother is sacrificed to the baby does not hold without qualification. (2) The response of babies to their food. Is the flying start of the breast-baby due to the composition of the colostrum? Babies are not, like lambs, dependent on the colostrum for a supply of antibodies from their mothers; antibodies (the antibody to the *Rh* factor, for example) pass through the human placenta. Both flying start and ability to suckle may both be evidence of a superior reproductive capacity. (3) The advantages, if any, of breast-fed babies that persist into later life. Mr. Wood points out that this information would be given only by long-term investigations based "on co-ordinated planning, a long time in advance, by some suitable 'ad hoc' committee or other body". Actually, very valuable work into the composition of human milk has been carried out, for two years, at the National Institute for Research in Dairying, supported by the Medical Research Council; and more extensive investigations, on the lines suggested, had been planned and work on them had started at the beginning of this year.

President Jefferson, Statesman-Scientist

THE recent bicentenary celebrations of Thomas Jefferson's birth have directed attention once again to the versatility of this remarkable man, some of whose special scientific interests are the subject of a 'pre-reprint' of 64 pp., with illustrations and maps, from *Chronica Botanica* (8, Nov. 1943), of a study by

Dr. Charles A. Browne, of the Bureau of Agricultural and Industrial Chemistry, U.S. Department of Agriculture, on "Thomas Jefferson and the Scientific Trends of his Time". The famous statesman-scientist —a type not unknown among the countrymen of Franklin, Rumford, and Hoover, and all too rare elsewhere—was, it appears, not greatly attracted by theory and speculation, which, indeed, he occasionally condemned in severe terms; his scientific interests were largely utilitarian, as is evidenced by many passages from his voluminous correspondence; and his outlook thus admirably fitted him to play the part of scientific scout for America during his residence in Paris as Minister to France (1784–89).

It is interesting to note that during these years in Paris, though he was an eye-witness of the chemical revolution effected by Lavoisier, he was sceptical about the new system of chemical nomenclature. Writing to Madison on this matter on July 19, 1788, he concluded: "The attempt, therefore, of Lavoisier to reform the chemical nomenclature, is premature. One single experiment may destroy the whole filiation of his terms, and his string of sulphates, sulphites, and sulphures, may have served no other end, than to have retarded the progress of the science, by a jargon, from the confusion of which, time will be requisite to extricate us. Accordingly, it is not likely to be admitted generally."

Jefferson's "Notes on the State of Virginia", his magnificent labours in bringing science to the service of the young and undeveloped country in the guidance of the destinies of which he was ultimately called to the highest place, his devoted work for agriculture, and his outstanding services to the cause of science in education, are all well summarized in this interesting memoir.

Stars with Large Proper Motions

A. van Maanen has prepared a paper with this title (*Astro. Soc. Pacific*, Leaf. 176; 1943) which deals with the developments in the discoveries of stellar motions, from the time of Tobias Mayer who determined the motions of several stars in 1760, by comparing his own observations with those of Römer made fifty years earlier. A useful table gives the proper motions of thirty stars with the largest proper motions, in all cases exceeding 3″ annually. Large proper motion suggests relative proximity to the earth, and for this reason it is not surprising that nineteen of the thirty stars are less than 16·3 light-years distant from the sun, and seven are nearer than 32·6 light-years. A very interesting feature in the table is the luminosity of each star, that of the sun being the unit. Only one star—ω Centauri *A*—is brighter than the sun, its luminosity being 1·14. The table also shows that stars with the faintest luminosities belong to the most advanced spectral types and so have the lowest temperatures, with the exception of the white dwarfs. The luminosities of the latter are very low, that of Wolf 489 being only 0·00008.

Electrical Aspect of Farm Mechanisms

A paper on this subject was read in London recently by Mr. C. A. Cameron-Brown before the Institution of Electrical Engineers in which, for the benefit of those interested but not actively engaged in rural electrification, a picture is drawn of the general developments of electrical participation in farm processes; the paper also offers a clearing house of ideas for those actively engaged in rural electrification but whose interest is localized. The paper is devoted chiefly to the less common applications, to those which are the subject of controversy, and to those which may appear to have a wider field of application in the future. Emphasis has been placed on trend rather than on facts and figures; thus Mr. Cameron-Brown covers general trends and observations, specific applications of electricity to farming operations such as grinding mills, threshing, crop drying, milk production and certain special applications. The scope of the paper is confined to general farming—arable, dairy and mixed.

Theodor Puschmann (1844–1899)

Prof. Theodor Puschmann, the eminent medical historian, was born on May 4, 1844, at Lowenberg in Prussian Silesia. He studied medicine successively at Berlin, Marburg, Vienna and Munich, and qualified at Marburg in 1869. He first made a study of psychiatry under von Gudden at Munich and then practised for some years in Cairo. In 1878 he specialized in the history of medicine at Leipzig, and in the following year was appointed extraordinary professor of medical history at Vienna, becoming full professor in 1879 in succession to Prof. R. Seligmann. He died on September 28, 1899. His principal publications were an edition of Alexander of Tralles (1878–79), a "History of Medical Education" (1889) and "Medicine in Vienna during the last 100 Years" (1884). He also wrote the introduction to a great work on the history of medicine which was completed by Prof. Max Neuburger and J. Pagel. His name has been given to a medico-historical institute in Leipzig founded by his wife.

Announcements

The twenty-third Silvanus Thompson Memorial Lecture of the British Institute of Radiology will be delivered by Prof. Sidney Russ on May 20; he will speak on "The Man Silvanus Thompson".

A whole-day conference of the Nutrition Society will be held on May 20, beginning at 10.30 a.m., at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1, on "Budgetary and Dietary Surveys of Families and Individuals, Part 2". Papers will be communicated by Miss E. M. Widdowson and Dr. R. A. McCance ("Dietary Surveys by the Individual Method"); Dr. Gertrude Wagner ("Surveys of Methods Used in Preparing and Cooking Foods"); Dr. G. N. Jenkins, Dr. L. W. Mapson and Miss M. Olliver ("Laboratory Assessment of Nutritive Value of Meals as Eaten"); Miss E. M. Langley ("Food Consumption: Data Obtained from Analyses of Institutional Diets: (*a*) School Diets"); Dr. M. Pyke ("Food Consumption: Data Obtained from Analyses of Institutional Diets: (*b*) Industrial Canteens"); Dr. A. Lyall ("Food Consumption: Data Obtained from Analyses of Institutional Diets: (*c*) Hospital Diets"). The openers of the discussion will be Prof. V. H. Mottram, Mrs. Barbara Callow, Dr. C. P. Stewart and Miss M. C. Broatch.

Erratum.—In connexion with the article in Nature of April 29 on "X-Ray Analysis in Industry", Mr. C. W. Bunn states that the concluding sentence on his paper (p. 534, col. 1) should read "This last effect has been observed in polyethylene, and confirmed by the magnetic properties of single crystals of chain compounds".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Molecular Co-ordination in Cellulose

No published hypothesis completely satisfies the evidence on the structure of cellulose, though the approximations derived by workers from Polanyi onwards have provided brilliant essays in reducing chaos to order. What appears to be a closer approximation is described below. A thorough treatment of all the lines of more or less indirect evidence supporting this hypothesis has been held up since the outbreak of war, but the bald description may be of value to those interested in cellulose from other points of view, and may enable those possessing modern forms of atomic models to check the probability of the structure.

In the crystalline structure of cellulose suggested by Meyer and Misch[1], the unit cell contains four glucose residues related by two screw axes. This co-ordination is essentially orthorhombic, with no molecular feature capable of maintaining the distortion to monoclinic form. The latter is also denied by the clear existence of odd orders of $(o\ k\ o)$ diffraction, particularly $(o\ 3\ o)$. Geometrical calculation does not confirm that their assumptions on atomic bond lengths, and angles give a molecular unit that fits into the unit cell—the cellobiose unit is longer than the identity period (b) observed, which is 10·3 A.

The molecular form was reconsidered in view of the studies in the crystallo-chemistry of the sugars by Cox and co-workers[2]. Their view that the five carbon atoms of the pyranose ring are nearly coplanar was expressed in a rigorous model, suited to geometrical calculation, built on the assumption of tetrahedral carbon bonds, with a right angle between the bonds of the ring oxygen. It fits into the cellulose lattice better than the Sachse form of strainless ring, though the details of the structure derived would be improved by making the ring carbons more nearly co-planar, by straining the tetrahedral angles to anything less than 111°.

When the chains are oriented with the principal plane of the rings in the $(a\ b)$ plane of the lattice, the primary alcohol group appears to approach and to form hydroxyl bonds with the pair of secondary alcohol groups of the neighbouring parallel chain. As the chains are related by a pure translation normal to the b or chain axis, this possibility of hydroxyl bond formation is an accidental coincidence due to the particular stereochemical form. If the coincidence were perfect, the orthorhombic symmetry of the $(P_{2_1 2_1 2_1})$ group would be retained. The observed distortion suggests that this uncovenanted bonding is only realized by sacrificing one of the four possible bonds.

In the molecular model, the freely rotating primary alcohol group has an alternative bond, with two oxygen atoms of the same chain. The displacement of the primary alcohol groups on one side of one of the two sets of chains to form this chelate bond explains quantitatively the odd order $(o\ k\ o)$ spots, with the intensities described by Kiessig[3]. It also allows and maintains the slight distortion of the basic $P_{2_1 2_1 2_1}$ cell, to a form which is strictly triclinic P_1.

In a re-examination of the evidence, a different choice from that of Meyer and Misch was made of the b parameter which determines the relative position of the two sets of anti-parallel chains. This new choice better fits the evidence on the regenerated form of cellulose.

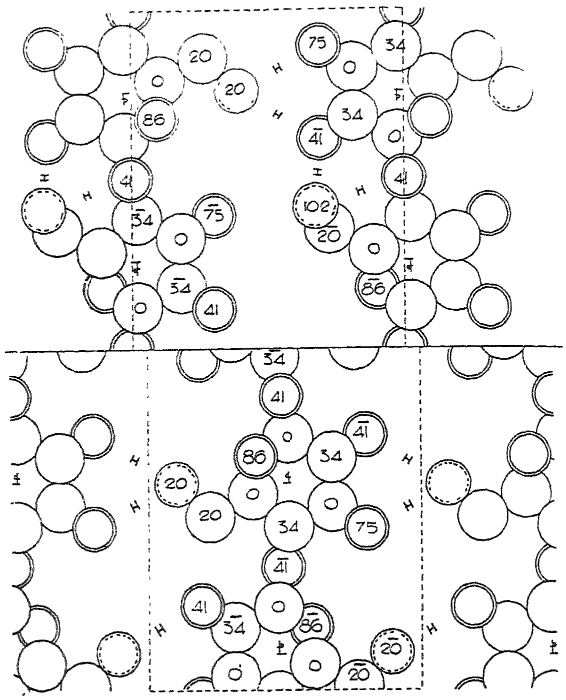

FIG. 1. NATIVE CELLULOSE.

In this form, the pyranose rings are turned from the plane of similarly oriented chains towards the plane containing chains of alternating sense. On general grounds, this is a more normal form of co-ordination, as it gives extra freedom for the formation of local bonds with stringent steric demands. A value of the b parameter in accord with the X-ray evidence produces a model with a series of hydroxyl bond possibilities, best explained by the plan of the cell (Fig. 2). Again such local bonds are necessary to explain the loss of symmetry, from the orthorhombic $(B_{2\ 2_1\ 2})$ cell that would be produced by eight identical units to the observed monoclinic P_{2_1} cell, described by Andress[4].

The regenerated form should be that of lower free energy, as it appears to be from the phenomena of dimorphism. The alternative forms of cohesion between cellulose chains, shown by the two forms

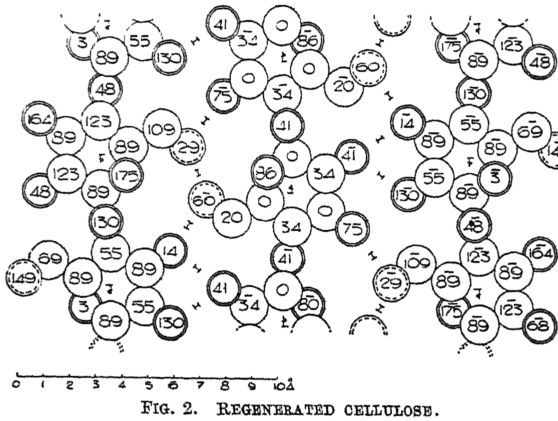

FIG. 2. REGENERATED CELLULOSE.

(which are freely available for local contacts in the deranged regions of cellulose) and the slight distortion from an orthogonal lattice of the crystalline regions (which may occur in either sense to suit the environment) provide a mechanism for the adaptation of the ordered molecular structure to the histology of tissues, and for the production of a strong, but adaptable, continuous lattice work of chains. In such a structure, one can scarcely define strict crystal boundaries; but some statistical description of the distribution in size and locality of the crystallized regions or 'fascicles' is essential for progress in the quantitative theory of fibre behaviour. In particular, the reaction kinetics of polymeric bonds in groups is determined by the size of the group as well as by the energy of the individual bond. This effect of polymeric co-operation explains the striking difference in the physical chemistry of polymers from that of the monomeric congeners.

The molecular structures assigned to cellulose are given in Figs. 1 and 2. Both are projections of the mats of chains on the plane in which the pyranose ring lies, to the scale shown, with normal displacements from the reference plane shown by figures in units 10^{-10} cm., plain above, barred below. In Fig. 1 the plane of reference is the $(a\ b)$ plane of the lattice described by Meyer and Misch; in the top half through the set of chains with chelate bonds; in the bottom half through the set below the first, at a distance $\frac{1}{2}\ c.\sin\beta = 3\cdot 93$ A. In Fig. 2 the plane of reference lies in the plane of the rings in the central chain, normal to the (101) plane of the lattice adopted by Andress (the small monogram in each ring indicates the symmetry operations, and the sign H represents a hydroxyl bond).

The models were constructed by geometrical calculation, assuming the lengths of C–C bond 1·52 A., C–O bond 1·43 A.; the O–O hydroxyl bonds suggested are about 2·6 A. Material models might be cut rather smaller to allow fitting in space.

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April 3.

[1] *Helv. Chem. Acta*, **20**, 232 (1937).
[2] Particularly in *J. Chem. Soc.*, 1495 (1935).
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[4] *Z. phys. Chem.*, **B4**, 190 (1929).

Molecular Shape and Size of Hyaluronic Acid and Chondroitinsulphuric Acid

THE hyaluronic acid, which was first isolated from vitreous humor[1], and later has been found in, for example, synovial fluid[2] and navel cord tissue[3] gives highly viscous solutions and is often precipitated as fibres. Its molecules have therefore been assumed to have a chain structure. The chondroitinsulphuric acid gives less viscous solutions and is precipitated at most in small fibres of little coherence. Levene and La Forge[4] tentatively expressed its structural formula as a tetrasaccharide, a view which seemed to receive support from von Fürth and Bruno[5], who by the aid of Northrop's diffusion method obtained a molecular weight of about 975.

Both these polysaccharides are rapidly degraded by alkali even at room temperature[6] and are also very easily broken down by oxidative agents[7]. In order to obtain the substances in a state as native as possible, they must therefore be prepared without the use of alkali and excluding air. We have found that solutions of hyaluronic acid and chondroitinsulphuric acid so prepared show a marked double-refraction of flow. The hyaluronic acid preparations were all rather polydisperse. For those isolated from vitreous humor, the particle-length was estimated to about 4800 A. The hyaluronic acid from synovial fluid showed a higher degree of polymerization with a particle-length of about 700 A.; that from the navel cord was still more polymerized, the particle-length lying outside the range that could be estimated with the apparatus used[8]. An extrapolation attempted from viscosity measurements gave a value of the order of about 10,000–12,000 A. These results leave no doubt of the long-chain structure of the hyaluronic acid and, assuming a length of about 10 A. of the disaccharide unit, suggest molecular weights of the order of 200,000–400,000.

The chondroitinsulphuric acid appeared somewhat less polydisperse. The best preparations showed particle-lengths of about 4700 A. This acid, too, has thus without doubt a linear structure, the molecular weight probably being of the order of 200,000.

A detailed report of this work will be published elsewhere.

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Lattice Constant of Diamond and the C–C Single Bond

RECENTLY, Lonsdale[1] has published a brief account of her measurements on single crystals of diamond using the divergent beam method[2]. At the same time, measurements were made by me on a specimen of diamond dust employing the X-ray powder method developed to a high degree of precision by Bradley and Jay[3] and others. The two sets of measurements are of interest to the physicist because they provide a comparison of the accuracy obtainable by the powder method with that obtainable by Lonsdale's method; they are of interest to the chemist because they lead to the most accurate value yet of the C–C single bond in diamond.

The specimen was obtained from commercial diamond dust by sieving through a very fine bolting-silk sieve (*c.* 175 mesh). The sizes of the small diamond crystals were therefore in the range 0·01–0·001 cm. approximately. The method used was that described by Lipson and Wilson[4]. The lattice constant of diamond is such that the *K*-radiations of cobalt, iron and manganese are most suitable for precision measurements as they give the 19 β, 16 β and 11 α_1 + 11 α_2 lines respectively at high angles (*c.* 80°). A 19-cm. diameter camera was used; in addition, one photograph was taken in a 9-cm. diameter camera of the van Arkel type. The apparent

lattice constants for the high-angle lines in each photograph were plotted against $\sin^2\theta$, and the result extrapolated to $\sin^2\theta = 1$. In this extrapolation more weight was given to the high-angle values and to the α_1 values as compared with the α_2. It was not considered advisable to use the analytical method of least squares in preference to graphical extrapolation in order to arrive at the best values for a. For if the former method is used, giving an equal weight to each observation, it will give rise to a misleading result; if, on the other hand, different weights are given to the various observations, the method becomes subjective and possesses no advantages over the graphical solution besides being very much more tedious and lengthy. It was, furthermore, obvious from the plots of apparent lattice constants against $\sin^2\theta$ that in each case *all* reasonable extrapolations would give rise to a value of a lying within the region bounded by the limits of error quoted below. The graphical method was therefore adopted. The values obtained, after correction for refraction, are summarized in the accompanying table. The temperature at which the photographs were taken was 18° ± 0·5° C.

Radiation	Camera diameter	a in kX.	Arithmetic mean
Co	19 cm.	$3{\cdot}5595_7$	
Co	19 ,,	$3{\cdot}5595_9$	
Fe	19 ,,	$3{\cdot}5597_8$	$3{\cdot}5596_5$ kX.
Fe	9 ,,	$3{\cdot}5596_1$	
Mn + Cu	19 ,,	$3{\cdot}5597_1$	

The five results are in good agreement and lead to a value for a of 3·5597 kX., the limits of error being ± 0·0001 kX. This is in excellent agreement with Lonsdale's figure of 3·55970 ± 0·00020 kX. (at 18° C.), the variation here referring to different specimens. Dr. Lonsdale gives the limits of error in measuring any *one* diamond as ± 0·00005 kX., which are twice as good as those obtainable by the X-ray powder method and allow her to add a further significant figure. Dr. Lonsdale points out, however, that this very high accuracy is attainable only in exceptional cases, the case of diamond being particularly favourable. This comparison demonstrates the power of the X-ray powder method, which combines the advantages of nearly universal application with simplicity of technique.

The C–C single bond. The C–C bond in diamond is a 'pure' single bond, as there are only carbon atoms present. An accurate knowledge of its length is of interest because it provides a norm from which to measure divergencies from 'pure' single bonding in carbon compounds. Although it has been decided, for the time being, to give lattice constants on the kX. (Siegbahn) scale, it is advisable to quote chemical bond-lengths in Angström units, as they are the basis of spectroscopic measurements. For this purpose a conversion factor of 1·002034 is used[5]. The results, taking Lonsdale's value, are shown below.

a in kX.	a in A.	C–C in kX.	C–C in A.
3·55970	3·56694	1·54140	1·54453
± 0·00020	± 0·00020	± 0·00009	± 0·00009

The C–C bond-length in diamond is therefore 1·5445 ± 0·0001 A.; there is a slight variation from specimen to specimen, but the effect of temperature is small. This value has been arrived at by two completely different methods, and other X-ray measurements[6] on single crystals of diamond are also in agreement. In any one specimen, Lonsdale's method permits a still more accurate knowledge of bond-length; thus, in the specimen measured by her giving a = 3·55974 ± 0·00005 kX., the C–C bond length is 1·54455 ± 0·00002 A.

It is clear that X-ray methods are capable of measuring bond-lengths with very great accuracy in certain cases. An accuracy of one part in 30,000 is relatively easily achieved in the measurement of lattice constants, and where the lattice constant is defined in a simple geometrical way by the bond-length under consideration, this length can be determined with comparable accuracy. Similar measurements are being undertaken for graphite with the view of fixing accurately two points on the order/length curve for C–C bonds.

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March 23.

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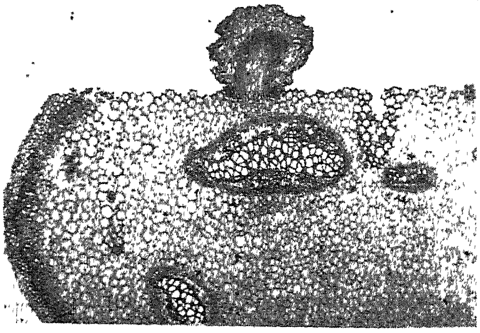
Bud Regeneration at Cut Parenchymatous Surfaces in Onocleoid Ferns

IT has been shown that the removal of the rhizome apex in the ostrich fern (*Matteuccia struthiopteris*) and in *Onoclea sensibilis* is attended by bud development at specific positions along the rhizome. These positions are occupied by superficial areas of meristematic cells, or detached meristems, which at an earlier stage formed part of the apical meristem. Those buds which arise in older regions of the rhizome have no vascular connexion with the shoot stele[1,2].

Two further significant observations have now been made: (1) that if a young induced lateral bud of *Onoclea sensibilis* is excised, new buds may arise from the cavity so produced; and (2) if the superficial tissue containing a detached meristem is removed, that is, as a thin tangential section, from the rhizome of *Matteuccia struthiopteris*, bud development takes place at the cut parenchymatous surface immediately below the position occupied by the detached meristem. This is illustrated in the accompanying photograph: the bud, which is seen to have arisen from a cut parenchymatous surface, occupies a characteristic position, as do induced lateral buds,



Matteuccia struthiopteris. TRANSVERSE SECTION OF AN EXPERIMENTALLY TREATED RHIZOME SHOWING A BUD ARISING FROM THE CUT PARENCHYMATOUS SURFACE. (× 18.) (*Photo. by E. Ashby.*)

opposite a point of meristele conjunction in the vascular system of the shoot; the bud stele ending blindly in the cortical parenchyma.

The potentiality for direct meristematic activity which was known to be present in detached meristems is thus seen to extend locally into the underlying cortical parenchyma also. So far as I am aware, bud regeneration from the cut surface of cortical parenchyma has not hitherto been recorded among the ferns, though a somewhat similar phenomenon has been observed in the genus Lycopodium. These ferns thus appear to afford unusually favourable materials for the investigation of meristematic activity and regeneration phenomena.

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A New Antigen of Salmonella

Following the study of a new salmonella type (*S. hormœchei*: XXIX.Z30.—.) made by one of us (M.), which has a flagellar antigen not referred to before (*Z*30), we find it in *S. ballerup* (XXIX.(Vi). *Z*14.—.) and in other salmonella (*LC*54) isolated from Buenos Aires sewage; this new antigen has been named *Z*30.

Natural selection and artificial induction show that this "H" *Z*30 antigen occurs in *S. ballerup* with or without *Z*14. Only after careful selection is it possible to obtain *Z*30 or *Z*14 alone.

The salmonella type obtained from Buenos Aires sewage (*LC*54) presents the curious phenomena of a flagellar phase variation in a new aspect: $Z30 \rightleftharpoons Z14$. This can be demonstrated using the Sven Gard method of artificial induction of flagellar phases. We have named this variation the 'Zeta Variation'.

Another interesting phenomenon has been observed in the *LC*54 strain. When it has the flagellar antigen *Z*30, the somatic antigen observed is XXIX; but when *Z*14 is present, it is not found.

We are continuing the study of the subject, of which the above is a preliminary account of work we have been doing since September 1942.

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Production of Seed Potatoes in a Hot, Dry Climate

After Maldwyn Davies's demonstration[1] that low temperatures and high relative humidities were needed to check the flight of the aphids that transmit potato virus diseases, it was widely accepted that these conditions were necessary for growing healthy seed potatoes. The absence of these conditions over most of South Africa, and difficulties in importing seed during the past few years, led to a review of the question, and it has been found beyond reasonable doubt that Davies showed only one side of the picture. Very high temperatures and low relative humidities are as effective as low temperatures and high humidities. At both ends of the scale there is an extreme at which the potato will thrive, but aphids not; it is in intermediate climates that heavy infestations occur.

The first demonstration of the value of a hot, dry climate escaped recognition. Porter[2] showed that at Davis, in the hot Sacramento Valley of California, the spread of virus diseases in potatoes was slow provided that their planting was delayed until mid-summer; and making use of this fact he produced seed for three years which was both healthy and productive. In Australia, Norris and Bald[3] noticed at Canberra that hot, dry weather reduced infestation, but the spells there seem to be too short to be of much use. The evidence in South Africa is that there is an optimum temperature for aphids at which infestation reaches a peak, and that rising temperatures above this optimum progressively reduce the population of aphids until a point is reached at which it virtually disappears. A similar suggestion of an optimum was made by Stepantzev[4]. From observations on the weather conditions favouring infestation of cotton fields in Uzbekistan, he concluded that numbers of *Aphis gossypii* Glov. and *A. laburni* Kalt. were greatest when the mean day and night temperatures were 20° C. (68° F.) and 18° C. (64·4° F.), respectively. Optimum temperatures of about the same order, or a little lower, seem to hold for the aphids *Myzus persicæ* Sulz. and *Macrosiphum solanifolii* Ashm. in potato fields in South Africa; but it is more to the point to determine how high the temperature must be before infestation practically ceases. This happens when the mean daily maximum temperature for the summer months is 32° C. (90° F.), which is the condition in dry, central South Africa around Kimberley. This must not be confused with the highest temperature at which aphids will grow and reproduce in the artificial state of a pure colony in a glasshouse. It refers to field conditions, and is strongly influenced by the host plant. In the field, *Myzus persicæ*, for example, will thrive on cabbages at higher temperatures than on potatoes. Very decidedly, high temperatures will not control all aphids on all crops.

Like high temperatures, very dry air is harmful to aphids, as Stepantzev also pointed out, and is important if seed potatoes are to be grown in hot climates. The Sacramento Valley is in a winter-rainfall zone, and aphids flourish in the mild, moist weather of spring. Consequently, Porter was able to control the spread of virus diseases there only if potatoes were not planted before mid-summer. This allows only one generation a year, which in a hot climate is not enough to stop seed from becoming over-sprouted and stale between harvesting and replanting. At Kimberley, on the other hand, winter rains are negligible; with rising temperatures in early summer the air becomes so dry that aphids are held in check, and there is no dangerous interval between winter and summer. Two crops can be planted, one in August to emerge after the last frost, and one in summer, about January. Since potatoes ripen quickly in a hot climate, these intervals between plantings are enough to allow two generations in one year, with just sufficient time between to sprout the seed.

During the past three years, counts of aphids have been made on thousands of leaves in hundreds of acres of potatoes in all stages of growth at the Vaal Harts and Riet River irrigation settlements near Kimberley. The records are such as few of the world's seed areas apart from the west coast of Ireland could

boast. The average of all counts of *Myzus persicæ* was 1·1 per 100 expanded compound leaves. The highest record was 10 on 275, or 3·6 per 100, compound leaves; this was in April, when the vines were ripening and the danger of virus spreading presumably almost past. Also important is the fact that the life of an aphid in these conditions is so hazardous and short that the vast majority of records were of very young nymphs which could not possibly have transmitted diseases like leaf-roll with a long incubation period in the insect.

To meet the critical shortage of good seed, brought about by reduced imports, action was taken in 1943, and more than 1,000 tons was raised by State production at these two settlements. This found its way throughout the length and breadth of the Union, and in the crucial test of productivity proved to be the best ever available in bulk in the country. The production in 1944 will be still higher; and since yields of seed per acre on the settlements have been excellent, the outlook for the future is bright.

The great limitation of seed production in hot, dry climates is its restriction to varieties in which the symptoms of diseases are not masked by heat. So far, only Up-to-date, South Africa's most popular variety, has been produced in quantity. This is immune in the field to virus *A*: and all diseases to which it is subject (apart from virus *X* with which all commercial stocks are now saturated) remain evident in hot weather, though sometimes in a modified form. A start is now being made with Katahdin.

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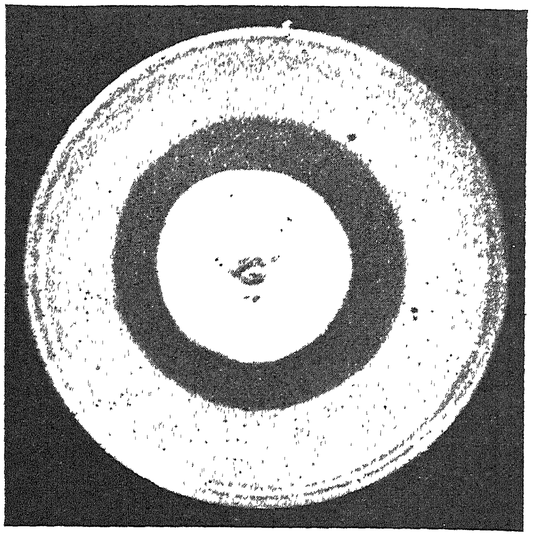
Estimation of the Anti-Bacterial Activity of Fungi that are Difficult to Grow on Liquid Media

THE more detailed work on the quantitative estimation of bacteriostatic substances has been concerned with the assay of penicillin, and the most generally favoured method is the 'cylinder' method as given by Abraham *et al.*[1], amplified by Heatley[2] and discussed by Foster and Woodruff[3]. On beginning our investigation in 1941, the above method was tried but, though apparently satisfactory for its original specific purpose, we found it to be less so for the widespread estimation of the bacteriostatic effect of fungus extracts and metabolism solutions than a method devised by ourselves[4]. Briefly, this method consists of putting a few drops of the liquid to be tested into a circular hole cut in the centre of a plate of bulk-seeded agar medium, with the subsequent production, after incubation at 37° C., of a zone of bacterial inhibition the width of which varies in proportion to the concentration of the bacteriostatic substance. This method only differs from somewhat similar methods mentioned by other workers in that the standardized technique enables it to give a relatively quantitative estimation.

This method has been used for the testing of some


5 MM. ZONE OF INHIBITION PRODUCED BY A 'MYCELIAL DISK' AGAINST *Staph. aureus*.

thousand fungus products of various kinds with complete success; but it is not so useful for the testing of fungi such as the larger Basidiomycetes which are sometimes difficult to grow in culture, usually grow very slowly and do not grow well on liquid media. For fungi of this kind the preliminary test described below will considerably reduce the experimentation time. Assuming a pure culture of the fungus to have been isolated, this is grown as a plate colony on 20 ml. of its most favourable medium. The most generally useful medium is 2 per cent malt extract in distilled or tap water with 2 per cent agar. When the colony has attained a diameter of about 2–2½ in., which may be anything from one to three weeks after inoculation, it may be tested as follows.

Plates are poured containing 20 ml. of nutrient agar to which has been added a suspension of the bacteria against which the test is to be made. Allow these to cool to between 50° and 45° C., then, with a sterile cork-borer, cut from the colony a disk of mycelium and agar and drop it into the centre of the still warm bacterial agar plate. The disk will settle into the agar and the fungus will appear as if it had originally grown there. Incubate at 37° C. overnight. The following morning, if bacteriostatic substances have been produced, there will be a clear, bacteria-free zone around the edge of the disk.

In order to facilitate comparison with the 'hole' method, the mycelial disks are cut out with the same size of cork-borer, namely, 11 mm. diameter. As the medium in the plate containing the fungus colony is always of standard depth, the mycelial disks are of uniform volume. All disks are cut at approximately the same distance from the edge of the colony. The nutrient agar is made up exactly as in the 'hole' method and the concentration of the bacterial suspension is kept as similar as possible.

The advantage of the above method is that, in our experience, the positive or negative result obtained in the test indicates the type of result to be expected if the fungus were to be grown in liquid culture. This shortens the experiment by approximately a month, as the negative fungi can be eliminated forthwith. The method is applicable to any type of fungus, but it is particularly useful for those with a non-sporing mycelium such as the Basidiomycetes, which have

to be grown by the 'disk-inoculum' method. It amplifies, but in no way supersedes, the method in general use in this Laboratory.

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Influence of Green Food on the Prevention of Piglet Anæmia

PIGLET anæmia is a microcytic hypochromic anæmia which may affect suckling pigs during the first 21–30 days after birth, especially when they are reared in such a way that access to pasture is excluded. The treatments at present adopted aim at supplying an additional amount of iron to the suckling pigs, either by dosing them individually or by allowing them access to a box of soil which is sometimes dressed with a solution of iron salts.

During the winter of 1943–44, investigations were undertaken to determine the possibility of prevention of anæmia in the suckling pigs by adjusting the diet of the pregnant sows. Four sows which had been running at pasture were housed in concrete-floored styes with open concrete-floored runs one month before they were due to farrow. The following ration was fed at the rate of 6 lb. per day during pregnancy and 10 lb. a day during the lactation period: pollards 60 per cent, beanmeal 30 per cent, fishmeal 10 per cent. To this was added 2 per cent of a mineral mixture containing calcium carbonate 35 per cent, bone ash 35 per cent, salt 18 per cent, ferric oxide (comm.) 12 per cent. Two of the sows received, in addition, two plants of marrow stem kale daily. Weaning of the litters was commenced five weeks after birth.

The litters were weighed bi-weekly and the blood of each piglet was examined at frequent intervals. In the accompanying table are shown the average values for one litter in each group at 2 days, 27–28 days and 51 days.

Age (days)	Erythrocytes (10^6 per c.mm.)	Hæmoglobin (gm. per 100 c.c.)	Packed volume (per cent)	Mean Corpuscular Vol. (μ^3)	Mean Corpuscular Hæmoglobin ($\gamma\gamma$)	Mean Corpuscular Hæmoglobin Conc (per cent)
Group *A* (Kale).						
2	7·01	13·5	50 2	71·6	19·3	26·9
28	5·18	7·0	32·0	61·7	13·5	21·8
51	6·9	11·1	46·5	67·5	16·2	24·0
Group *B* (no green food).						
2	4·61	9·7	34·8	75·5	21·2	28·0
28	5·3	5·3	24·4	46·0	10·0	21·8
51	6·05	7·8	30·5	50·5	12·4	25·7

The piglets in Group *A* remained free from anæmia while those in Group *B* became anæmic.

A preliminary trial is in progress to determine the nature of the factor or factors in the kale responsible for the effects described above.

The above is a summary of the findings of work financed by a grant from the Agricultural Research Council. It is intended to publish the findings in full elsewhere.

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Viscosity and Contraction of Unstriated Muscle

THERE is a close resemblance between the effects of ions on the protoplasmic viscosity of simple organisms and plants on one hand and their effects on the viscosity of unstriated muscle on the other. The viscosity of the protoplasm in these simple organisms can be measured by standard methods (for literature see ref. 1), but the viscosity of unstriated muscle is measured by comparing it to known viscous-elastic systems[2,3]; the similarity of the effects on simple organisms and on muscle gives an insight into the structure of the latter, and further establishes the validity of the indirect methods for determining its viscosity.

Sodium and potassium increase, and magnesium and calcium decrease, the viscosity of the *interior* protoplasm of the sea-urchin Arbacia, of the protozoa Stentor and Amœba, and of the alga Spirogyra. In the *cortical* protoplasm of Amœba, calcium causes a pronounced stiffening of the cortical gel, and this effect is antagonized by sodium, potassium and magnesium; potassium has the strongest liquefying effect, magnesium the next and sodium has the least action. Potassium loses its liquefying action in acid solution. The effect of acids is increased in the absence of calcium.

The effects noted above were reproduced in studies of the action of ions on the viscosity of Mytilus muscle. If the sodium chloride of the saline is replaced with calcium, magnesium or potassium chlorides, the viscosity is increased in the order Ca > Na > Mg > K. Indeed, potassium is the most powerful agent I have known for decreasing the viscosity; the effect of potassium is completely counteracted if the *p*H of the saline is reduced to 5 – 4·4. The effect of acid is increased in the absence of calcium. If smaller concentrations of potassium are used (0·1 *M* potassium chloride), then sodium and potassium increase the viscosity, and calcium (0·01 *M* calcium chloride) and magnesium (0·03 *M* magnesium chloride) decrease the viscosity, as in the interior protoplasm of Amœba.

These experiments suggest that plain muscle fibres consist at least partly of undifferentiated protoplasm like that of Amœba. The fact that isolated myosin is effected by temperature, alkalis and distilled water[4] in a similar way as isolated living muscle[3], as described previously, suggests that the contractile element of the muscle consists of myosin.

Plain muscle fibres thus consist of (*a*) a viscous element, (*b*) a non-viscous contractile element. This view is in agreement with (1) the differential action of drugs, (2) the visco-elastic properties, and (3) the histological picture of the muscle. Thus calcium decreases the viscosity of both the guinea pig uterus and Mytilus muscle, but causes contraction of the former and relaxation of the latter. Similarly, hydrogen ions increase the viscosity of Mytilus muscle, but may cause relaxation or contraction. Lastly, histologists have described plain muscle

fibres as consisting of fibrils embedded in sarcoplasm. The contractile fibrils may be disseminated throughout the sarcoplasm, or may be collected into a peripheral zone[5].

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Origin of the Planets

THE development of planets from a filament of material formed between two separating stars may not prove so great a difficulty in the theory of the origin of the solar system as is suggested in Dr. Jeffreys' recent letter[1]. It has generally been maintained that the filament would be of such small mass and at such high temperature that its immediate dispersal would occur by lateral expansion. But this view neglects the force field of the two stars transverse to their line of centres, which in the early stages is enormously in excess of the gravitational field of the filament and of enough strength to control thermal velocities due to stellar temperature.

In the lengthwise development, the residual differential attraction of the two stars opposes the self-gravitation of the filament, and to begin with may slightly preponderate, though the two effects are of the same order. At first, pressure differences must urge the matter towards the neutral point, while later the transverse force field of the stars may also be concerned, since during the orbital motion after closest approach their line of centres rotates through more than 90°. The possibility of tidal disruption would not be a fatal objection however, since it is not required that the filament should collect into a single mass. At least three primitive planets must have remained captured by the sun, and possibly others may have escaped, so there seems to be a need for some tendency for the filament to break into a number of masses. But the only worked-out cases of tidal action by stars refer to steady equilibrium forms, and the various forces have unlimited time to operate; such examples do indicate that tidal forces may affect the filament, but they do not enable us to go so far as to say that tidal forces will prevent its gathering into planets.

The situation is in any case much improved as compared with the earlier ideas in that it is sufficient if aggregations form with masses of the order of those of the present great outer planets. There is no necessity for bodies as small as the terrestrial planets to form initially; indeed, the differences of composition of the four inner planets, now ascertained, could scarcely have resulted from simple condensation in the original filament.

There are of course difficulties in the theory, but they are chiefly analytical in nature and are not fundamental inconsistencies involving serious order of magnitude discrepancies. Moreover, the initial hypotheses that lead to material being removed from a star by collision with another, or by rotational instability, have valid observational and theoretical warrant, whereas most proposed alternative starting points are very gravely deficient in this respect. The nebular hypothesis, the planetesimal hypothesis with its bolts shot from the sun, the meteoric swarms, and the lately revived hypothesis of a distended primeval star, all picture initial conditions for the sun that have no support in theory or observation. This is not to say that such hypotheses must be incorrect (though experience shows that they usually are), but they could not be regarded as satisfactory until their connexion with accepted hypotheses had been made clear: that is, until the omitted stages of the theory had been filled in, and this may as well be attempted first as last. Such hypotheses should be preceded by the essential astrophysical investigations demonstrating their legitimacy.

One further point. The central situation of the sun in the solar system is settled by its mass and is not a consequence of the mode of origin of the system. Accordingly, it is not valid to infer from its central position that the sun is necessarily the parent body.

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Rate of n-fold Accidental Coincidences

THE time-rate of an accidental coincidence (resolving time t) of n Geiger counters with time rates N_1, $N_2 \ldots N_n$, is most easily obtained by classifying the coincidences according to the counter which goes off first. The time rate of each class is obviously $N_1, N_2 \ldots N_n t^{n-1}$, and hence the total time-rate is

$$R_n = n\, N_1 N_2 N_3 \ldots N_n t^{n-1}, \quad (1)$$

as indicated by Jánossy[1]. The present derivation shows that the formula is *exact* on the understanding that any two groups fulfilling the requirements are counted separately, even when they differ only by one of the n constituent pulses. But physical counting will as a rule distinguish at best such coincidences as differ with regard to all n constituents. That is how the terms of higher order in t mentioned by Jánossy come in. They are sort of a 'correction for overlapping'.

Let us compute the next approximation. The most frequent kind of 'overlapping' (order t^n) occurs when $n + 1$ pulses (two of them from the same counter, say, from No. 1) crowd, so as to contribute *two* coincidences to (1). There are two possibilities. All the $n + 1$ may fall within an interval t. The time-rate of *this* event is, analogously to (1),

$$nN_1^2 N_2 N_3 \ldots N_n t^n. \quad (2)$$

But, in addition, the two No. 1 pulses are allowed to have an interval $t + \tau$, greater than t, provided that the others fall in an interval $t - \tau$, situated midway between the two No. 1 pulses. The time-rate of *this* type of event is easily found to be

$$N_1^2 N_2 N_3 \ldots N_n \int_0^t (t-\tau)^{n-1}\, d\tau$$

$$= \frac{1}{n} N_1^2 N_2 N_3 \ldots N_n t^n \quad (3)$$

The sum of (2) and (3) and of the analogous expressions, with No. 2, No. 3 ... yielding the double pulse, is the correction to be subtracted on the right-hand side of (1). Hence the *next approximation* reads

$$R_n = n\, N_1 N_2 N_3 \ldots N_n t^{n-1}$$

$$\left[1 - \left(1 + \frac{1}{n^2}\right)\left(N_1 + N_2 + \ldots + N_n\right)t\right]. \quad (4)$$

Note added in proof.—The factor n in (2) is a

'howler', as I discovered thanks to Dr. Jánossy's criticism. From elementary principles it must be $\frac{n-1}{2} + 1 = \frac{n+1}{2}$. In (4) you then get the factor $\frac{1}{2} + \frac{1}{2n} + \frac{1}{n^2}$ in lieu of $1 + \frac{1}{n^2}$.

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[1] Jánossy, L., NATURE, 153, 165 (1944).

A TREATMENT of the higher order terms of the fold accidental rate is given by Prof. Schroedinger. A treatment leading to a slightly different result follows. Assume that pulses of the counters 1, 2, . . . $n-1$ arrive in the time intervals t_1, $t_1 + dt_1$, . . . t_{n-1}, $t_{n-1} + dt_{n-1}$ with

$$0 \leqq t_1 \leqq t_2 \leqq \ldots \leqq t_{n-1} \leqq t,$$

where t is the resolving time. The above pulses together with one from counter n at the time $t_n = t$ give rise to an n-fold coincidence. The probability per unit time of such an event is

$$P = N_n(N_1 dt_1) \,.\, (N_2 dt_2) \ldots (N_{n-1} dt_{n-1}) \quad . \quad . \quad (1)$$

To obtain a unique classification of the coincidences, we select all those coincidences under (1) for which the pulse of counter 1 in the interval t_1, $t_1 + dt_1$ is the first pulse of this counter to contribute to the coincidence. Both necessary and sufficient conditions for this are that no pulse of the counter 1 should arrive in the interval 0 to t_1. The probability for this is $\exp(-N_1 t_1)$. Imposing similar conditions on the pulses coming from the other counters, one finds,

$$P' = \exp(-N_1 t_1 - N_2 t_2 - \ldots N_{n-1} t_{n-1} - N_n t) \,.\, P, \quad (2)$$

where P' is the probability that the pulses from the counters arrive in specified time intervals and that the first pulses from the counters 1, 2, . . . n taking part in the coincidence arrive in a specified order. The total coincidence rate is obtained by integrating over the t_1 ($i = 1, 2 \ldots n-1$) and summing over the $n!$ permutations of the counters. We thus obtain

$$R_n = N_1 N_2 \ldots N_n \sum_{\text{perm.}} e^{-N_n t} \int\int_{t_1 = t_2 = \ldots t_{n-1} = 0}^{0 \leqq t_1 \leqq t_2 \ldots \leqq t} \ldots \int P' \, dt_1 \, dt_2 \ldots dt_{n-1}$$

$$= \sum_{\substack{\text{cyclic} \\ \text{perm.}}} e^{-N_n t} (1 - e^{-N_1 t}) \ldots (1 - e^{-N_{n-1} t}) \quad . \quad . \quad . \quad . \quad . \quad (3)$$

For $n = 2$ one finds

$$R_2 = N_1 e^{-N_1 t} + N_2 e^{-N_2 t} - (N_1 + N_2) e^{-(N_1 + N_2)t}.$$

Developing (3) into powers of t one finds,

$$R_n = n \,.\, N_1 \ldots N_n t^{n-1} \left[1 - \left(\frac{1}{2} + \frac{1}{2n}\right)(N_1 + \ldots N_n)t\right] + \ldots \quad (4)$$

It is seen that (3) reduces to the expression I gave[1] when neglecting higher powers of t. (The expression for R_n giving the lowest power of t only was also given by Eckart and Shonka[2] some time ago.)

Regarding the practical applications, we note:

(1) In a counter arrangement consisting of n counters, the accidental coincidences are usually due to various overlappings. One has to consider the overlap of a single pulse with a genuine $(n-1)$-fold coincidence; further, one has to consider the overlap of two single counts with a genuine $(n-2)$-fold coincidence, etc. Thus one obtains for the rate of accidental coincidences an expression containing various powers of t. This expression may have no meaning if the higher powers in the terms due to low multiplicities are neglected.

(2) The expression (3) is only valid if the ineffective time following each pulse is short compared to t. In most practical cases, however, the ineffective time will be larger than t. In those cases the expression neglecting higher powers gives the correct rate.

Note added in proof.—The difference between the results as given above and as given by Prof. Schroedinger seems to be connected with the question as to what combination of pulses is recorded as one n-fold coincidence. My picture is as follows. Each pulse sets off the recorder for a time t. Any *connected* period of time for which the recorder is set off by all n counters is counted as 'one coincidence'.

I am indebted to Prof. Schroedinger for an interesting correspondence.

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[1] Jánossy, NATURE, 153, 165 (1944).
[2] Eckart and Shonka, *Phys. Rev.*, 53, 752 (1938).

Donnan Membrane Potential

IN a recent communication in NATURE (July 17, 1943, p. 76) I applied the Boltzmann distribution law to the Donnan membrane equilibrium between two compartments, compartment (1) containing colloidal (or non-diffusible) ions plus diffusible ions, compartment (2) containing only diffusible ions. From the equations obtained, it follows that at the same pH of the solution the ratio of the membrane potential (E'_m) for a dibasic acid to the membrane potential (E_m) for a monobasic acid should be

$$\frac{E'_m}{E_m} = \frac{\frac{RT}{N^*F} \cosh^{-1} \frac{3y+z}{3x}}{\frac{RT}{N^*F} \cosh^{-1} \frac{2y+z}{2x}} = 0\cdot66 \text{ nearly,}$$

where y is the concentration of positive, $y + z$ that of negative ions in compartment (1), x the concentration of positive and negative ions in compartment (2), $N^* = \frac{1}{2}(N_1 + N_2)$, N_1 is the valency of the cation, N_2 is the valency of the anion, and z is *small*. At the same pH value of the solution, z in the case of sulphuric acid is not equal to z in the case of hydrochloric acid. According to Donnan, at the same pH of the protein solution, the value of E'_m/E_m has been given as $\frac{2}{3}$. or 0·66 by Loeb. But this ratio should be 0·66 nearly, since the value of z is different in the two cases.

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Copper Carbonyl: a Correction

RECENTLY[1] we described a volatile compound, traces of which were formed when a variety of specimens of cuprous oxide were heated in carbon monoxide, as a carbonyl of copper. Further experiments have shown that the phenomena observed resulted from adventitious halide present in the oxides used.

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Newcastle upon Tyne. April 24.

[1] Robinson and Stainthorpe, NATURE, 153, 24 (1944).

ACTIVATION OF PYRETHRINS IN FLY-SPRAYS

By W. A. L. DAVID and P. BRACEY

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MOST mosquito- and fly-control sprays contain pyrethrins, so that, during the present shortage, methods of economizing pyrethrins are of considerable importance. One accepted method of effecting an economy is to add to the spray a small proportion (usually less than 5 per cent) of a material which although not insecticidal in itself yet has the property of making the pyrethrin spray a great deal more effective. Such non-toxic additions are commonly called adjuvants or activators; for example, *iso*-butylundecylenamide[1] and sesame oil[2]. So far as we are aware, this phenomenon of activation has never been explained, and indeed certain observers have experienced difficulty in demonstrating its existence.

We have recently had occasion to examine the efficiency of many spray formulæ containing adjuvants. The method used consisted of exposing the test insect *Aëdes aegypti*, reared under standard conditions, to the spray-mist produced in a cabinet maintained at 28° C. and 70 per cent relative humidity. An Aerograph M.P. paint spray-gun adjusted to produce a finely divided mist served as the atomizer. A sample of the mist mechanically deposited showed that when odourless distillate was sprayed at 0·5 oz. per 1,000 cu. ft., practically no droplets above 7·5 microns in diameter reached the sampling apparatus at the end of the first minute after spraying. The insects were introduced into the cabinet four minutes after spraying, enclosed in paper-walled cages having wide-mesh gauze ends, through which the mist penetrated. They remained in the cabinet for ten minutes.

With the test system outlined we have come to the conclusion that: (1) The four activators tested delay the occurrence of 'knockdown' and so prolong the period of flight through the mist. As the activator content of the spray is increased, within limits there is a progressive increase in the percentage kill recorded, and at the same time a progressive delay in the occurrence of knockdown. These statements may be illustrated by data on *iso*butylundecylenamide.

Insecticide	% Knockdown (min.) 2	4	6	8	10	Av. percentage kill after 24 hr.
Pyrethrins, 0·1 % wt./vol.	10	95	100	100	100	50
Pyrethrins, 0·03% wt./vol.	5	20	97	100	100	20
Pyrethrins, 0·03% wt./vol.; *Iso*butylundecylenamide, 0·50% wt./vol.	0	10	40	95	97	27
Pyrethrins, 0·03% wt./vol.; *Iso*butylundecylenamide 1·50% wt./vol.	0	5	15	75	95	55

(2) The insect picks up its dose of insecticide by impaction with the spray droplets during its period of flight through the mist. Since this is the case, the delay in the occurrence of knockdown gives the insect a greater chance of picking up a heavy dose of insecticide. The importance of flight through the mist is confirmed by two observations. Insects in the following conditions were exposed to the spray mist simultaneously: (*a*) not chloroformed; (*b*) chloroformed and recovered; (*c*) chloroformed but wings were removed before recovery; (*d*) chloroformed—still motionless when exposed. Unsprayed chloroformed controls all recovered.

State of insects	Average percentage kill after 24 hr.
Not chloroformed (*a*) ..	62
Chloroformed and recovered (*b*)	58
Wingless (*c*)	13
Under chloroform (*d*) . ..	12

The low kill with the walking (wingless) and motionless insects will be noted in comparison with that of flying insects. (Another possible suggestion, which is, however, largely discredited by observation 3, is that there was greater intake of spray mist through the spiracles of the flying insects due to increased respiratory exchange.

(3) The rate of movement of the insect in relation to the droplet and the relative momenta are important. The test procedure was modified so that the spray mist moved past insects which had been chloroformed at known speeds. The same total volume of atmosphere was passed over the insects in the two cases below.

Wind speed m.p.h. (approx.)	Average percentage kill after 24 hr.
0·3	8
3·0	97

(4) Activation of sprays by adjuvants can be demonstrated by the method outlined in (3) above. Here the insects do not fly through the mist, hence prolongation of the period of flight (discussed in (1)) is not the only factor in activation.

Insecticide	Average percentage kill after 24 hr. (wind speed 3 m.p.h. approx.)
Pyrethrum, 0·10% wt./vol. ..	96
Pyrethrum, 0·05% wt./vol. ..	53
Pyrethrum, 0·05% wt./vol.; activator, 5·00% wt./vol.	100

In the above table the activator may be either sesame oil, *iso*butylundecylenamide or lubricating oil; in all cases the kill obtained was 100 per cent.

(5) All the above-mentioned activators have a very marked effect on the particle size and persistence of the insecticidal mist. This is due not to the slight effect on the degree of atomization originally produced at the spray-gun nozzle, but to the fact that all the activators are substances of low vapour pressure, so that they persist when the more volatile carrier has evaporated. A comparison of non-activated and activated mists mechanically deposited ten minutes after spraying from an atmosphere dosed with approximately 0·5 oz. per 1,000 cu. ft. shows that, whereas the former contains few droplets per litre 5 microns or bigger, with an activated spray mist there are very many thousands. Further measurements of size and persistence are being made, and at this stage satisfactory figures cannot be given.

(6) Following the observation of the effect of an activator on particle size, it was expected that many substances of low vapour pressure would show this kind of activation. This has been found to be the case with olive oil, oleic acid, sesame oil free from sesamin and lubricating oil, for example.

Insecticide	Average percentage kill in 24 hr.
Pyrethrins, 0·05% wt./vol. ..	12
Pyrethrins, 0·10% wt./vol. ..	65
Pyrethrins, 0·50% wt./vol.; oleic acid, 5·00% v./v. ..	89
Pyrethrins, 0·50% wt./vol.; olive oil, 5·00% v./v.	73
Pyrethrins, 0·50% wt./vol.; lubricating oil, 5·00% v./v.	80
Pyrethrins, 0·50% wt./vol.; sesame oil free from sesamin, 5·00% v./v.	81

From the cabinet tests there seems to be little doubt that two of the factors which contribute to activation are (1) prolongation of the period of flight through the mist; (2) increased persistence of droplets of the order of 10 microns in diameter.

This physical explanation of activation does not cover the whole of the facts. For example, the observation of Haller *et al.*[3] that pure sesamin at 0·2 per cent is capable of acting as an effective activator against the housefly, whereas certain allied substances fail, is not covered.

We have been able to show activation against *Aëdes aegypti* with pure sesamin and, as mentioned earlier, with desesaminized sesame oil. The occurrence of knockdown is also delayed by pure sesamin.

Insecticide	%Knockdown (min.) 2	4	6	8	10	Av. percentage kill after 24 hr.
Pyrethrins, 0·05% wt./vol.*	2	40	95	100	100	36
Pyrethrins, 0·05% wt./vol. } * Sesamin 0·20% wt./vol. }	0	20	60	95	100	75

* Both dissolved in 10/90 v./v. mixture of acetone and kerosene.

When sesame oil, *iso*butylundecylenamide or lubricating oil is used in the spray formula, the resulting droplets after evaporation consist of a solution of pyrethrins in a medium which is considerably more viscous than that resulting from an unactivated spray. They are also less concentrated. It was originally thought that the higher viscosity and lower concentration of pyrethrins in the droplets (resulting from the activated spray) delayed the penetration of pyrethrins and so the occurrence of knockdown. However, this explanation does not account for the delaying effect shown by sesamin and so probably has little validity.

When a spray droplet evaporates, non-volatile insecticides persist as sub-microscopic particles, as may be shown by spraying a dyed oil and mechanically depositing the resulting mist after four minutes. A cloud of dye, unassociated with oil, is obtained. Under suitable conditions the particles which persist when using any of the activators mentioned here, except sesamin, are of the order of 1–10 microns, and within this range impaction occurs at lower velocities. It appears that there is an optimum final droplet size for securing a maximum kill. If the droplet is too small, impaction with the insect does not take place; whereas if it is too large, the toxic principle is rapidly lost from the air space by sedimentation. Here it may be noted also that, for a given activator content of the spray, the final droplet size will depend upon the size of the particles produced by the atomizer. Theoretically, therefore, it would be expected that for an atomizer giving a coarse spray a lower activator content would be required than for a fine spray, since after evaporation the coarse spray leaves a residual droplet which may be so large that it will be rapidly lost by sedimentation.

At the time of writing we have some evidence that activation becomes more apparent as the degree of atomization produced by the gun increases. Finally, it is perhaps worth emphasizing that only *Aëdes aegypti* has been employed in these tests, and that the conclusions may not hold good for other insects.

This work is being carried out under a grant from the Medical Research Council.

[1] Weed, A., *Soap*, **14**, No. 6, 133 (1938).
[2] Eagleson, C., *Soap*, **18**, No. 12, 125 (1942).
[3] Haller, La Forge and Sullivan, *J. Econ. Ent.*, **35**, 247 (1942).

THE CEDAR TREE

By ALEXANDER L. HOWARD

ALTHOUGH the cedar tree is not indigenous to Great Britain, it has been established so long and has become a peculiar and ornamental feature of our parks around country houses, churches, and rectories, and so much admired that its absence would be a grievous loss. It is safe to affirm that up to seventy years ago very many thousands of trees could be counted throughout the country. During this period many have been destroyed, blown, or cut down, and it would be difficult to count up to four figures the numbers which have been replanted. Unfortunately, in too many cases a little cedar tree was planted close to the house, the original owner failing to recognize that the time would come, and that soon, when the cedar tree would top the house, so that additional loss has been caused by so many fine trees of this character having to be sacrificed.

The cedar is reared with difficulty. Many years ago the capable gardener at Mill Hill School told me that it had taken him several years—I think from six to nine—before he had been able to raise one tree from the well-known Linnean cedars there. William Boutcher in "A Treatise on Forest Trees", dated 1776, says:

"The way that was first practised for procuring their seed, was by splitting the cones length-ways through the centre, with a sharp piece of iron, and to pick them out with your fingers, which may be easily done, after the cones have been exposed some hours before a warm fire. Should the cones be two years old, they will emit their seed more freely than when just gathered, and the seed equally good.

"The best soil to raise these plants in, is that of a rich old cow pasture, which, if not naturally of a light quality, must be mixed with a fourth or fifth part of sea-sand, or that taken from the sides of rivulets, to be well blended together for some months, before it is used. I have already mentioned that this tree will not require any attention after it has arrived to the age of three or four years, nor is it very delicate from the beginning; yet at the same time, it is absolutely necessary to give them abundant nourishment at first, in order to raise a fair and vigorous plant; for if they once become dwarfish, stunted, or to lose their leading shoot, no art will be possible ever afterwards to restore them to a good figure."

Strutt says, in 1830, while mentioning that the cedar has not been much cultivated in England until of late years:

"its quick growth and its capability of thriving in a meagre soil, renders it peculiarly desirable for those bleak and barren situations which have hitherto been principally devoted to the fir. The frequent and solemn allusions to the Cedar in Holy Writ, seem to give it something of a sacred character; which is increased by a knowledge of the esteem in which it was held by the ancients, on account of its fragrant scent, its incorruptible nature, and above all its durability, insomuch that it is recorded that in the Temple of Apollo at Utica, there was found timber of Cedar nearly 2,000 years old."

From the financial aspect, no satisfactory result can be expected, and suitable sites for planting will be increasingly difficult to find. Only an enthusiastic desire on the part of those who might be able to re-afforest the country with this noble tree can prevent its final disappearance.

There is only one true cedar.

Quoting from "Timbers of the World":

"Under this commercial name (cedar) a motley collection of woods is included. In the first place comes the true cedar, a coniferous genus, Cedrus, of which there are three species or varieties: the cedar of Lebanon, the deodar, and the Mount Atlas cedar. Another coniferous type, the Port Orford cedar (*Cupressus Lawsoniana*), should more correctly be termed a cypress, for the tree is familiar in gardens under the name of Lawson's cypress. The pencil cedars, being the wood of several American species of Juniperus, are truly junipers and likewise conifers. All these woods possess a very fragrant scent. It is not surprising that the name cedar has popularly, and hence commercially, been attached to the cigar-box, a West Indian wood derived from a tree (*Cedrela odorate*) which is in no way allied to Cedrus but is a member of the mahogany family (Meliaceae). Other species of Cedrela, including the Indo-Australian *C. Toona* and *C. australis* and the Paraguayan cedar *C. braziliensis*, are more or less fragrant and receive the name cedar.

"The wood of Cedrela in many respects resembles mahogany, and has to some extent similar characteristics, so that the name has been extended to various American, African, etc., woods, which more or less resemble in appearance those of Cedrela, though not necessarily possessing any fragrance or strong scent. Some of the woods belong to the mahogany family, some do not, while the sources of still others are unknown. Then again there is in British and Dutch Guiana the so-called cedar, the product of *Protium altissimum*. The tree is not a cedar, nor has it any of the characteristics, and it is entirely without the fragrant scent usually associated with that wood.

"Further confusion arises owing to the fact that between mahogany and cedar woods of the Cedrela type there exist transitional forms, which are termed mahoganies or cedars according to the will of the vendor."

There are three different kinds of true cedars belonging to the genus Cedrus. The differences between them are so slight and fluctuating that all three are frequently included under one botanical name, *C. Libani*: sometimes, however, each is given a separate name. All are mountain trees; the first-named growing on Mount Lebanon, in Cyprus, and the Orient; the second being Himalayan, and the third African and growing on the Atlas Mountains. All these are grown in English gardens. The timbers of the three kinds are almost indistinguishable. An easy way of identifying the varieties has been mentioned to me, though it should be taken as general and not absolute: L. for Libani, l. for level (the branches extend from the tree in a more or less horizontal manner); D. for Deodar, d. for drooping (the branches generally droop); A. for atlantica, a. for ascending (the branches generally slope upwards).

Besides the references to cedar wood in the Bible, and in the earliest Greek and Roman writings in their poetry and prose, Pliny says:

"As for Cedars, the best simply be those that grow in Candie, Affricke, and Syria. This virtue hath the oil of Cedar, that if any wood or timber be throughly anointed therewith, it is subject neither to worm nor moth, ne yet to rottenness. The Juniper hath the same properties that the Cedar. They prove in Spain to be exceeding big and huge, the berries also greatest of all others. And wheresoever it groweth, the heart thereof is more found than the Cedar. . . .

. . . "the kings of Egypt and Syria, for default and want of Fir, have used (by report) instead thereof Cedar wood about their shipping. And verily the voice goeth of an exceeding big one which grew in Cyprus, and was cut down for a mast to serve that mighty galleace of king Demetrius, that had eleven bankes of oares to a side; a hundred and thirty foot it was high, and three fatham thick. And no marvel, since that the pirates and rovers who haunt the coasts of Germanie, make their punts or troughs of one entire piece of wood and no more, wrought hollow in manner of a boat, and some one of them will hold thirty men."

Although we have evidence that some of the wood of the true cedar was actually used, it is probable that by far the greater number referred to other scented woods. No greater confirmation of the above confusion over the name can be advanced than the interesting and informative remarks contained in Pliny's Discourse. He says:

"The great Cedar, called by the Greekes Cedrelate, as one would say, the Fir-Cedre, yieldeth a certain pitch or paraffin named Cedria, a singular medicine for the tooth-ache; for it breaketh them, fetcheth them out of the head and easeth all their pain. . . . This kind of pitch were excellent for the eyes but for one discommoditie, in that it causeth headache. It preserveth dead bodies from corruption, a world of years: contrariwise, living bodies it doth purifie and corrupt. A strange and wonderful propertie, thus to mortifie the quicke, and quicken (as it were) the dead. It marreth and rotteth apparell, as well linnen as woollen: and it killeth all living creatures."

And further:

"Also the Phœnicians have a lesse kind of Cedars much like to the Juniper; and two sorts there be thereof, the Lycian and the Phœnician, which differ in the leafe: for that which hath an hard, sharpe, and prickie leafe, is called Oxycedrus: full of branches it is besides, and so knurrie, that it is troublesome to the hand. As for the other Cedar, it hath an excellent smell. . . . And the timber of it is everlasting: wherefore in old time they were wont to make the images of the gods, of this wood, as it appeareth by the statue of Apollo Sofianus, made of Cedar wood, brought from Seleucia. In Arcadia there is a tree like the Cedar, but in Phrygia it is called a shrub."

We might be in doubt, since Pliny describes the tree, using the word "fir", but afterwards he speaks of "berries" and "fruit", which while it is a true description of the foliage, is not a description of the cones of cedar of Lebanon. It is possible that the translation from Pliny's Latin to our language explains the point, as Strutt in his "Sylva" sets all doubts at rest when he refers to cedar of Lebanon and further says:

"It entered largely into the construction of the most celebrated buildings of antiquity; and in the glorious Temple of Solomon it seems to have been recorded of it, as one of its proudest boasts, that 'all was Cedar; there was no stone seen'.

Elwes says the cedar was introduced into England during the seventeenth century, and quotes Loudon "who held the Cedars at Chelsea mentioned . . . in England". But he says further that Mr. Challis informed him that he counted 236 rings on the Hammersmith tree when fallen, which would date the introduction back to 1638. Strutt mentions the Hammersmith Cedar, which at the time he wrote measured 16 ft. 6 in. in circumference at the ground, 59 ft. in height, and branches covering an area of 80 ft.

According to Dr. Hunter in his notes in Evelyn's "Silva":

"The trees in the Apothecaries Garden at Chelsea were planted in 1683. In 1774 they had attained a circumference of 12½ feet at 2 feet from the ground, while their branches extended over a circular space 40 feet in diameter. 27 years afterwards the trunk of the largest one had increased more than ½ ft. in circumference: this shows the quickness of its growth in proportion to that of the Oak, which in the same period would probably not have made half that progress."

Strutt says:

"The Enfield Cedar stands in the garden of the Manor House, or old Palace in Enfield, the occasional retirement of Queen Elizabeth before she came to the throne, and the frequent scenes of her royal pleasures afterwards, in the early part of her reign. In the year 1660 it became the residence of the learned Dr. Uvedale, master of the Grammar School of Enfield at that time, and famous for his curious gardens and choice collection of exotics. The Cedar, which is now perhaps the largest in the kingdom, was put into the ground by him, a plant brought direct from Mount Libanus. In 1779 it measured 14 ft. 6 in. at the base, and 45 ft. 9 in. in height, 8 ft. of the upper part having been broken off by a high wind in 1703. The principal branches extended in length from the stem from 28 to 45 ft., and the contents of the tree, exclusive of the boughs, was about 293 cubic feet. In 1821, Dr. May, its present proprietor, and the master of the Grammar School at Enfield, took its measurement, which was as follows: 17 ft. in circumference at 1 ft. from the ground, 64 ft. in perpendicular height, and containing 548 cub. ft. of timber, exclusive of the branches, which from north-east to south-west extend 87 ft. and contain about 250 ft. of timber, making in the whole nearly 800 ft. of timber."

A remarkable cedar (*Cedrus Libani*) at Brockett Hall, in full vigour of life, measures 18 ft. in circumference, with fine healthy bark to the height of 20 ft., where it branches out with huge limbs. The total height is 80 ft., and from the crown there are nine branches averaging 35 ft. long, each 4–5 ft. in circumference, giving a roof span of 62 ft. It is a beautiful specimen, having regard to its great age. At Brockett Hall there are 85–90 cedars in the Park, of which 45 or more are *C. Libani*, 2 *C. Deodara*, and about 40 *C. atlantica*.

The Rev. C. A. Johns gives an interesting account of the introduction of the cedar tree into France, as follows:

"Many years ago a Frenchman, who was travelling in the Holy Land, found a little seedling among the Cedars of Lebanon, which he longed to bring away as a memorial of his travels. He took it up tenderly, with all the earth about its little roots, and, for want of a better flower-pot, planted it carefully in his hat, and there he kept it and tended it.

"The voyage home was rough and tempestuous, and so much longer than usual, that the supply of fresh water in the ship fell short, and they were obliged to measure it out most carefully to each person. The captain was allowed two glasses a day, the sailors, who had the work of the ship on their hands, one glass each, and the poor passengers but half a glass. In such a scarcity you may suppose the poor Cedar had no allowance at all. But our friend the traveller felt for it as his child, and each day shared with it his small half glass of precious water; and so it was, that when the vessel arrived at the port, the traveller had drunk so little water that he was almost dying, and the young Cedar so much that, behold, it was a noble and fresh little tree, six inches high!

"At the Custom-house the officers, who are always suspicious of smuggling, wished to empty the hat, for they would not believe but that something more valuable in their eyes lay hid beneath the moist mould. They thought of lace, or of diamonds, and began to thrust their fingers into the soil. But our poor traveller implored them so earnestly to spare his tree, and talked to them so eloquently of all that we read in the Bible of the Cedar of Lebanon, telling them of David's house and Solomon's temple, that the men's hearts were softened, and they suffered the young Cedar to remain undisturbed in its strange dwelling. From thence it was carried to Paris, and planted most carefully in the Jardin des Plantes. . . . The Cedar grew larger and larger, and became the noblest tree there."

Those who have only seen cedars in England, or even been fortunate enough to have visited Mount Lebanon, can have no conception of the glory of these trees in the Himalayas. The late Sir George Hart, inspector-general of forests, made a wonderful collection of pictures, some of which I have. The wealth and magnificence of the cedars in the Himalayas is beyond description: the measurement of some is recorded by J. S. Gamble, who says of the deodar that it is the principal timber tree of the Himalayas, and quotes Thomson ("W. Him. and Tibet"), who mentions:

"One near Nachar on the Sutlej that had 35½ ft. in girth. Brandis mentions trees in Kunawar that had 30 to 36 ft. in girth; Dr. Stewart measued one at Kuarsi, in the valley of the Ravi, that was 44 ft. at 2 ft. and 36 ft. at 6 ft. from the ground, and another was ascertained to be 34½ ft. in girth, and to be about 900 years old. Minniken records a tree at Punang in Bashahr that was 150 ft. high, and had a girth of over 36 ft., the clean bole height being 45 ft. The great section in the corridor of the Imperial Forest School at Dehra Dun shows 23 ft. in girth and 665 annual rings, equivalent to about 13 rings per inch of radius; it came from the Gokul Forest in Tehri-Garhwal, and was cut by Mr. E. M. Moir. In the Moriru Forest in the Tehri-Garhwal Leased Forests, I measured in 1898 a stump—or rather shell, for the interior had decayed—that was 34 ft. in girth; while not far off, in Dumrali Block, a dry fallen tree was unearthed, 90 ft. long, and over 7 ft. in diameter at base. It had been dead for at least 100 years, and was, when it fell, probably 550 years old. . . . Aitchison mentions a tree in the Kuram Forests 22 ft. in girth and 150 ft. high. Schlich found a tree in the Sutlej Valley 240 ft. high; and W. R. Fisher tells me he saw one of 216 ft. in the Bashahr forests of the Pabar Valley."

From earliest times history continues to emphasize the high value placed on the tree and the wood of the cedar of Lebanon which the writings of the Greeks and Romans have handed down to posterity. The beauty of the tree is referred to over and over again in verse and prose, while the usefulness and durability, and the chemical properties, are emphasized. It is curious to notice that in spite of what was within our knowledge and that we have been familiar with the tree in Great Britain for three hundred years, the former of these qualities has been only partially recognized, while the latter has been entirely ignored.

The wood forms a good medium for decorative furniture and panelling. The preference shown by architects and principals unfortunately excludes twisted grain and sound knots, which being admitted give admirable character and variety to the finished work. The trees imported from North Africa and India contain less knots and twisted grain, thus producing a larger proportion of clean boards. All three varieties mixed show no apparent difference and are equally aromatic and durable.

The cedars in the Apothecaries Garden, referred to earlier, were made use of for the manufacture of three chairs for the use of the master and wardens of the Apothecaries Company, and are still in regular use. They were exhibited at the Empire Timber Exhibition at Holland Park in 1920, and were greatly admired by all who saw them.

The Rev. C. A. Johns says:

"the value of the timber of the Cedar, as a building material, is now thought to have been over-rated by the ancients. It is reddish white, with streaks, and does not seem to be much harder than deal. It is sweet-scented only for the first year after its being felled: it soon begins to shrink and warp, and is said to be by no means durable. But

this is rather the character of English-grown Cedar than of timber which has come to maturity in its native mountains."

I do not find that I often differ from Johns, but in this case I am afraid that he is quite wrong. The quality and durability of English-grown cedar is in every way as good as that produced elsewhere, and the aromatic scent is persistent—undeniable facts which can be proved.

The forests of cedars on Mt. Lebanon, which were known to the civilized world nearly two thousand years ago, have gone. The Rev. C. A. Johns, in 1849, quotes Maundrell as follows, who measured the largest cedar on Mt. Libanus:

"I found it 12 yards 6 inches in girth and yet sound, and 37 yards in the spread of its boughs."

To-day the traveller would have difficulty in counting a score still remaining. This is a terrible illustration of the destruction of forests with the march of civilization. From every quarter of the globe, whichever way we turn, we are confronted with the same story.

Dr. Fosdick, in a book entitled "A Pilgrimage to Palestine", says, speaking of the country between Samaria and Galilee, and the Plain of Sharon by the sea:

"Whether or not there used to be more trees upon these hills than now has often been discussed, but I do not see how anyone can doubt it. In this last war alone (1914–1918) it is estimated that 40 per cent of all the olive trees in Palestine were cut down for military purposes. To say nothing of the locusts, two great enemies of the trees have ravaged the land for centuries—Militarists and goats. . . . When Pompey came to take Palestine for Rome, the record says that he cleared away the trees, and Josephus tells us that Titus cut down every tree within ten miles of Jerusalem. . . . Even in the Lebanons they are finding boundary stones set by Hadrian's foresters—I saw one in Beirut—where to-day only bare mountains remain. The forest of Hereth, where David hid, is gone; there is no forest of Bethal to shelter bears to-day; Kiriath-jearim, which means 'city of forests', would have no excuse now for such a name, and the woods of Sharon, which Strabo called 'a great forest', and which once stretched from the valley of Ajalon up to Mount Carmel, now have few relics of their ancient glory."

We should indeed be a decadent people if we allowed a thing of such beauty and interest as the cedar tree to vanish from our landscape.

ANTIBACTERIAL SUBSTANCES IN GREEN PLANTS

FROM the earliest times, writes E. M. Osborn (*Brit. J. Exp. Path.*, 24, 227; 1943), plants have been used in the attempt to cure disease. After giving a brief summary of recent work on the well-known occurrence of antibacterial substances in green plants, he records the results of his own investigation of about 2,300 different green plants, most of them flowering plants. All the plants used were freshly picked and all available parts of them were tested. The method of testing used was the diffusion method of Abraham and other Oxford workers (*The Lancet*, ii, 177; 1941), the antibacterial substance being tested against *Staphylococcus aureus* and *Bacterium coli*. The test shows only the presence or absence of the antibacterial substance and is not quantitative. A negative result does not necessarily prove the absence of the antibacterial substances, and the possibility of their destruction by enzymes must also be remembered.

At the time when this paper was written, antibacterial substances had been found in sixty-three genera of plants belonging to twenty-eight families. Extracts from plants belonging to the same families tend to show similar specificity and potency. Inhibiting substances are distributed throughout some plants (for example, *Asarum europæum* (Asarabacca)). In others their distribution is restricted. There is more of them in the seeds of *Brassica oleracea* (cabbage) than in other parts of this plant, and they were found only in the bark of *Magnolia acuminata*. This restricted distribution, together with differences in method of testing, may account for some negative results obtained with plants from which other workers have obtained bactericidal effects (for example, *Chelidonium majus* (greater celandine) and the turnip and horse radish). In many plants the inhibitory substances are produced by enzyme action; for example, *Plumeria bicolor*, *Cheiranthus cheiri* (wallflower) and *Crepis taraxacifolia* (hawk's-beard). In some instances the inhibitory substance is produced by the action of an enzyme situated in one part of the plant on an inactive precursor situated in another part of it. The drying of some plants causes loss of inhibitory power, for example, Clematis, Anemone, Ranunculus; but the drying of others does not (for example, *Crepis taraxacifolia* (hawk's-beard), *Reseda lutea* (wild mignonette) and *Asarum europæum*). Certain well-known drug plants (Atropa, Datura, Digitalis) show no inhibitory power against the organisms used, nor do many plants recommended by herbalists.

A table shows the species from which "frankly positive" results were obtained. A feature of it is the activity of the Ranunculaceæ tested, some of which (for example, Anemone, Clematis, Helleborus and Ranunculus) inhibit both *S. aureus* and *Bact. coli*. Extracts of some plants inhibit only *S. aureus*. Two of the plants tested were specific against *Bact. coli*. A full list of the species tested and the results obtained may be obtained from the Sir William Dunn School of Experimental Pathology, Oxford, and a similar list has been deposited in the archives of the Royal Society at Burlington House, London.

FREQUENCY PERFORMANCE OF QUARTZ PLATES

AN article by W. P. Mason (*Bell Lab. Rec.*, 22, No. 6; February 1944) discloses some of the results of researches carried out to determine the frequency performance of quartz plates cut and oriented in a variety of ways. The natural frequencies depend largely on the plate dimensions and orientation with respect to the faces and angles of the original crystal, and on temperature.

Rectangular co-ordinates x, y, z, were used for specifying the manner of cutting. The z, or optical axis, runs vertically up the centre of the hexagonal prism assumed by the crystal; the y, or mechanical, axis is taken perpendicular to any one of the three pairs of opposite faces; and the x, or electrical, axis runs horizontally through opposite edges of the crystal. The first crystals used were known as x-cut and y-cut. Both have their width parallel to the

z-axis, but the x-cut has its face perpendicular to the x-axis and its length parallel to the y-axis, while the y-cut has its face perpendicular to the y-axis, and its length parallel to the x-axis. For the x-cut crystal the voltage is applied along the electrical axis, and the vibration occurs parallel to the mechanical axis; the frequency is a function chiefly of the crystal length. For the y-cut crystal, the voltage is applied along the mechanical axis; voltages appear along this axis when the applied pressure is at 45° to the mechanical and electrical axes, and thus, when voltage is applied along the y-axis, the vibration is one of shear.

The factors that make it desirable to seek other forms of cuts may be illustrated with the x-cut crystal in which, when voltage is applied along the electrical axis, the vibration is along the mechanical axis. Motion along the electrical axis also gives a displacement of charge along the electrical axis, and thus the x-cut crystal could vibrate in either direction; but the vibration frequency, which will be determined chiefly by the dimension of the crystal in the direction of its vibration, will be much lower when the vibration is along the y-axis than when it is along the x-axis. As used, a voltage frequency was applied corresponding to the length vibration, and thus was comparatively low. If an effort were made to use the crystal for a high frequency, utilizing vibration along the x-axis, difficulties would occur because harmonics of the y-axis frequency might be very close to the x-axis frequency, and slight changes in conditions might cause the controlling vibration to shift from that of the x-frequency to a harmonic of a y-frequency.

The most common of such changes of conditions is the temperature, since the frequency of the x-cut crystal, and of the y-cut, is very sensitive to temperature changes. With a crystal of zero temperature coefficient, the frequency can be held to almost negligible variations by maintaining the crystal at the proper temperature. Accurate temperature control apparatus, however, is necessary when high constancy of frequency is desired. It would be very desirable if a crystal cut were available that had a zero temperature coefficient over a wide range of temperature, since this would make temperature control unnecessary over this range. Search for such a cut resulted in a crystal having a temperature coefficient essentially zero from 0° to 100° C. The various cuts, besides giving the temperature characteristics desired, are also selected, and the dimensions of the crystal chosen, so that there will be only one mode of vibration of fundamental or harmonic frequency in the neighbourhood of the frequency at which the crystal is to be operated.

THE 'MICROTIMER'

AN electronic timing device called the 'Microtimer' has been produced by R. K. Dundas, Ltd., The Airport, Portsmouth. This measures the time interval between the making, or alternatively, the breaking, of two electrical contacts, or between any other combination of contacts. In addition it may be operated, without contacts, by a suitable valve amplifier in conjunction with, for example, a photo-electric cell. The time indication is given by the position of a pointer moving over the dial of a meter, and the standard instrument has ranges covering 10 to 1,000 milliseconds for full-scale deflexion. It operates entirely from the standard A.C. mains, although a battery model is available. Tests show that the instrument has negligible zero drift, is simple to calibrate and use and is of rugged construction. After taking a measurement, the deflexion of the meter is maintained for several minutes without appreciable drift; throwing a switch brings the meter back to zero for the next measurement. The accuracy claimed is within ± 2 per cent of the full scale deflexion on any range, even allowing for violent changes in mains voltage or changes of the valves.

The principle of the circuit, which incorporates patented features, may be briefly described. A condenser is charged up from the high-tension supply, and at the beginning of the interval to be timed, the energy in this condenser is allowed to flow through a constant-current pentode valve into a precision condenser. At the end of the timed interval this current is stopped, and the voltage which has been built up across the precision condenser is measured by means of a high-impedance valve voltmeter, to which the output meter is connected, this meter being, of course, calibrated in milliseconds. A voltage stabilizer in the high-tension supply and the provision of considerable negative-feedback assist in maintaining the accuracy of calibration and freedom from drift.

The 'Microtimer', although designed as a laboratory instrument, may be readily operated in routine work by unskilled personnel, and may have a large variety of applications, such as timing the operation of relays, switches, fuses, contact breakers, camera shutters and automatic machinery of all kinds, and in radio, physical and explosives research.

FORTHCOMING EVENTS

Monday, May 15

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. John Beattie: "Clinical Aspects of Methionine Metabolism".

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Dr. Olaf Devik: "The Formation of Ice in Lakes and Rivers".

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Annual General Meeting.

Tuesday, May 16

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Lieut. Bernard Mishkin: "The Indians of the Andes".

Wednesday, May 17

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers.

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. John Beattie: "Clinical Aspects of Methionine Metabolism".

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 4.30 p.m.—Exhibition of a Soviet Film on "Animal Life in the Kara-Kum Desert", with commentary by Dr. Edward Hindle, F.R.S.; Dr. Ruth Deansley: Demonstration of the Breeding Habits and Life-cycle of *Xenopus*; Mr G. P. Wells: "The Parapodia of *Arenicola marina* L. (Polychæta)".

INSTITUTION OF ELECTRICAL ENGINEERS (WIRELESS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. R. B. Armstrong and Mr. J. A. Smale: "High Speed Recording of Radio-Telegraph Signals".

INSTITUTE OF WELDING (joint meeting with the INSTITUTE OF THE PLASTICS INDUSTRY) (at the Institution of Civil Engineers, Great George Street, Westminster, London, S.W.1), at 6 p.m.—Dr. J. H. Paterson: "The Welding of Plastics".

BRITISH INSTITUTION OF RADIO ENGINEERS (MIDLAND SECTION) (at the University (Latin Theatre), Edmund Street, Birmingham), at 6.30 p.m.—Dr. Emrys Williams: "Relaxation Oscillators and Trigger Circuits".

Thursday, May 18

ROYAL SOCIETY OF ARTS (DOMINIONS AND COLONIES SECTION) (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. H. C. Waite: "African Art".

ELECTRICAL ASSOCIATION FOR WOMEN (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Annual General Meeting.

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the PLASTICS GROUP and the BIRMINGHAM AND MIDLAND SECTION) (at the Chamber of Commerce, New Street, Birmingham), at 2.30 p.m.—Dr. J. Hofton: "Amino Resins".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. F. G. Mann "Some Aspects of the Organic Chemistry of Phosphorus and Arsenic" (Tilden Lecture).

INSTITUTE OF FUEL (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 6 p.m.—Mr R. H. Anderson, Mr. D. C. Gunn and Dr. A. L. Roberts: "Uses of Permeable Refractories for Furnace Construction".

Friday, May 19

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 4.30 p.m.—Dr. H. S. Souttar: "Team Work in the Treatment of Cancer" (Twenty-first Mackenzie Davidson Memorial Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5 30 p.m.—Dr. L. Hartshorn: "Foundations of Electrical Measurements".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Prof. G. V. Lomonossoff and Capt. G. Lomonossoff: "Condensing Locomotives".

Saturday, May 20

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10.50 a.m.—Conference on "Budgetary and Dietary Surveys of Families and Individuals", Part 2 (to be opened by Prof. V. H. Mottram, Mrs. Barbara Callow, Dr. C. P. Stewart and Miss M. C. Broatch).

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2 30 p.m.—Annual General Meeting; at 3.15 p.m.—Prof. S. Russ: "The Man Silvanus Thompson" (Twenty-third Silvanus Thompson Memorial Lecture).

INSTITUTE OF PHYSICS (joint meeting of the INDUSTRIAL RADIOLOGY GROUP and the MANCHESTER AND DISTRICT BRANCH) (in the Physics Department, The University, Manchester), at 2.30 p.m.—Mr. C. T. Snushall: "Filters and Intensifying Screens—their Applications in Light-Alloy Radiography".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE ASSISTANT MISTRESS to teach CHEMISTRY and PHYSICS to School Certificate and Higher School Certificate standard, at the Plymouth High School for Girls, and an ASSISTANT MASTER qualified to teach PRACTICAL PLANE AND SOLID GEOMETRY for Engineering and Building Courses, at the Plymouth Junior Technical School for Boys—The Director of Education, Education Offices, Cobourg Street, Plymouth (May 18).

EDUCATIONAL PSYCHOLOGIST (man or woman)—The Director of Education, Education Department, Town Hall, Crouch End, London, N.8 (May 20).

TEACHERS (with Graduate or equivalent qualifications) IN ENGINEERING AND BUILDING SCIENCE, ENGINEERING WORKSHOP SUBJECTS and TECHNICAL DRAWING (Engineering and Building), at the Wolverhampton Technical High School—The Director of Education, Education Offices, Wolverhampton (May 20).

LECTURER IN BIOLOGY (to give assistance with Chemistry), and a LECTURER IN CHEMISTRY (to give assistance with Biology or Physics), at the Hull Municipal Technical College—The Director of Education, Guildhall, Hull (May 20).

BACTERIOLOGIST for research work in connexion with Bovine Mastitis—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (May 20).

ASSISTANT to teach ENGINEERING DRAWING, MATHEMATICS, and ENGINEERING SCIENCE, at the Jarrow Technical School—The Director of Education, Shire Hall, Durham (May 22).

ASSISTANT ENGINEER for the Northern Rhodesia Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.697A) (May 24).

LECTURER IN CHEMISTRY—The Acting Secretary of University Court, The University, Glasgow (May 26).

TEACHER OF BOTANY in the Science Department, to take classes up to General Degree standard—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (May 27).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN CHEMISTRY—The Principal, Royal Holloway College, Englefield Green, Surrey (May 31).

ASSISTANT MASTER (with Graduate or equivalent professional qualifications) to teach MATHEMATICS AND GENERAL SCIENCE at the Scarborough Technical Institute—The Secretary, Education Offices, County Hall, Northallerton (June 3).

STAFF LECTURER IN SCIENCE AND HYGIENE—The Principal, Northern Counties Training College of Cookery and Domestic Science, at Tower House, Tweedmouth, Berwick-upon-Tweed (June 10).

HENRY MECHAN CHAIR OF PUBLIC HEALTH—The Acting Secretary of University Court, The University, Glasgow (June 15).

METALLURGIST by Firm of Engineers with wide interests (Ph.D., or equivalent, minimum technical qualification)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2286XA) (June 17).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W C 2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C 2 (July 31).

ARC WELDING ELECTRODE PRODUCTION ENGINEER, with experience of solid extrusions, to take charge of latest type manufacturing plant—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O.N.Q S 178).

LECTURER IN BACTERIOLOGY to students preparing for the National Diploma in Dairying—The Principal, Studley Agricultural College for Women, Studley, Warwickshire.

LABORATORY TECHNICIAN (male) holding the Certificate in Bacteriology of the Institute of Medical Laboratory Technicians—The Director of the Clinical Laboratory, Royal Infirmary, Manchester.

ASSISTANT MASTER FOR ENGINEERING SUBJECTS, at the Burton-upon-Trent Technical Institute—The Secretary and Director of Education, Education Offices, Guild Street, Burton-upon-Trent.

WELDING ENGINEER by a Steel and Engineering Firm in the North-East, to initiate and develop fabrication of steel forgings and castings of heaviest types—The Ministry of Labour and National Service, Appointments Office, 38 Great North Road, Newcastle-upon-Tyne (quoting Reference No. 397).

SENIOR STRUCTURAL DESIGNER (Reference No. O.S.86), and a CHIEF MECHANICAL DESIGNER (Reference No. O.S.87), by a large Firm of Structural and Mechanical Engineers in India—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting the appropriate Reference No.).

ASSISTANT (male) IN BIOCHEMISTRY at the Courtauld Institute of Biochemistry—The Medical School Secretary, Middlesex Hospital, London, W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 17: The Centenary of the First Geological Survey made in Ireland. By Prof. H. J. Seymour. Pp. 227–248. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s*. [174

Ministry of Health, Ministry of Agriculture and Fisheries, Department of Health for Scotland. A National Water Policy. (Cmd. 6515.) Pp. 32. (London: H.M. Stationery Office.) 6*d*. net. [194

Some Problems of International Organisation. By Prof. C. K. Webster. (University of Leeds: Second Montague Burton Lecture on International Relations.) Pp. 18. (Leeds: The University.) 6*d*. [204

Carnegie United Kingdom Trust. Thirtieth Annual Report, 1943. Pp. 8. (Dunfermline: Carnegie United Kingdom Trust.) [214

Imperial Agricultural Bureaux. Joint Publication No. 4: Co-ordinated Trials with Phenothiazine against Nematodes in Lambs. A Report prepared at the instance of the Agricultural Research Council of the United Kingdom. Pp. 56. (Weybridge: Imperial Bureau of Animal Health; St. Albans: Imperial Bureau of Agricultural Parasitology.) 3*s*. 6*d*. [214

War-time Information for Pharmacists. Compiled by the *Pharmaceutical Journal*. Third edition. Pp. 80. (London: Pharmaceutical Press.) 1*s*. 6*d*. [244

London Shellac Research Bureau. Abstracts bearing on Shellac Research Literature for the Period 1st January to 31st December 1943. Pp. ii+6+viii. Bulletin No. 6: Ethylene Glycol Ester of Hydrolysed Lac; its Preparation and Properties. By N. R. Kamath. Pp. 10. Technical Paper No 23: Ethers and Ether-Esters of Lac and their Polymerisation, Part 2. By Dr. B. S. Gidvani and N. R. Kamath. Pp. 24. Technical Paper No. 24: Plasticising Lac Films from Aqueous Solutions, Part 1. By Dr. B. S. Gidvani. Pp. 20. (London: London Shellac Research Bureau.) [264

Other Countries

Annals of the New York Academy of Sciences. Vol. 44, Art. 6: Psychosomatic Disturbances in relation to Personnel Selection. By Lawrence K. Frank, M. R. Harrower-Erickson, Lawrence S. Kubie, Gardner Murphy, Donal Sheehan and Harold G. Wolff. Pp. 539–624. Vol. 45, Art. 2: Lycaenidae of the Antilles (Lepidoptera, Rhopalocera). By William P. Comstock and E. Irving Huntington. Pp. 49–130. Vol. 45, Art. 3: New Methods in Stellar Dynamics. By S. Chandrasekhar. Pp. 131–162. Vol. 45, Art. 4: Studies on Fresh-Water Polyzoa, 14: The Occurrence of *Stolella indica* in North America. By Mary D. Rogick. Pp 163–178. Vol. 45, Art. 5: The Social Behavior of the Laughing Gull. By G. K. Noble and M. Wurm. Pp. 179–220. (New York: New York Academy of Sciences.) [114

Smithsonian Institution: Bureau of American Ethnology. Bulletin 140: Ceramic Sequences at Tres Zapotes, Veracruz, Mexico. By Philip Drucker. Pp. ix+155+65 plates. (Washington, D.C.: Government Printing Office.) 50 cents. [114

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 172: Zebu-cross Cattle in Northern Australia; an Ecological Experiment. By R. B. Kelley. Pp. 96+16 plates. (Melbourne: Government Printer.) [124

Bulletin of the Bingham Oceanographic Collection. Vol. 9, Art. 1: Tetrodon Poisoning. By Warren H. Yudkin. Pp. 18. (New Haven, Conn.: Yale University.) 30 cents. [124

U.S. Department of Agriculture. Leaflet No. 237: Control of Mole Crickets by use of Poisoned Baits. By C. B. Wisecup and N. C. Hayslip. Pp. 6. (Washington, D.C.: Government Printing Office.) [144

Public Library of South Australia. Annual Report of the Libraries Board of South Australia, July 1942 to June 1943. Pp. 6. (Adelaide: Public Library of South Australia.) [184

NATURE

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RECRUITMENT AND TRAINING OF TEACHERS

PRIMARY AND SECONDARY SCHOOL TEACHERS

WHEN the president of the Board of Education presented the now famous White Paper in July of last year, he made some reference to the coming need of a teaching profession which should be adequate, both in numbers and in quality, to a radically reformed system of education. At that time he found it inconvenient to say much more on the subject, except that there were "some things so patently wrong with the present system that an expert inquiry is long overdue". Again, the Bill which five months later followed the White Paper made no explicit reference to teachers, except that which achieved notoriety as Clause 82. In every other sense the turn of the teachers to stand in the limelight was still to come. So far back as March 1942, Mr. Butler appointed a committee, with Dr. (now Sir) Arnold McNair as chairman, "to investigate the present sources of supply and the methods of recruitment and training of teachers and youth leaders and to report what principles should guide the Board in these matters in the future". The long —and perhaps rather impatiently—awaited report has now been published, and will be known as the McNair Report. The delay is partly due to the appearance meantime of the White Paper and of the Norwood Report, but partly also, there is little doubt, to a difference of opinion which, so far from resulting in a mere minority report, split the Committee into two precisely equal groups.

The report is divided into four parts. Part 1 deals with teachers in primary and secondary schools and with the organization of training generally, Part 2 deals with youth leaders and teachers in young people's colleges, and Part 3 with teachers in technical colleges and schools. In Part 4 the special needs of Wales and some other important matters are considered. In the present article, we deal mainly with the problems raised in Part 1.

The magnitude of the problem of supply is familiar enough to experienced administrators, but for the general public it is best explained by a few figures. It is estimated that when the reforms proposed in the Education Bill are in full swing, the army of teachers required will be no less than a quarter of a million. Assuming that the present rate of wastage in the teaching profession will continue, primary and secondary schools alone will need an annual intake of at least 15,000 new teachers. So much for the coming need. On the other hand, we know that in the years immediately preceding the outbreak of war, the annual output of the existing training colleges and university training departments was less than 7,000. The cold figures are impressive enough, but they are by no means all. There never has been a clearly defined objective and a settled policy in Great Britain as to the supply and training of teachers, so that even before the War there was severe criticism of the recruitment of teachers, the institutions in

which many of them were trained, and the conditions of their subsequent service. Yet it is admitted on all hands, and proclaimed in no uncertain voice by the President of the Board, that the really educated democracy contemplated in the Education Bill can never be achieved unless the educational system is manned by a teaching profession adequate in numbers, carefully selected, and well trained.

At present, the avenue to the training college or department lies through the upper forms of the secondary, that is, the grammar schools, a source of supply which will now become quite inadequate. In order to obtain the required number of entrants of the quality desired, the Committee makes numerous suggestions which we can only summarize briefly. The field of recruitment, it says, should be widened to include boys and girls from senior (modern) schools and junior technical schools who may be suitable. More children in the grammar schools should be encouraged to consider teaching as a profession. The transfer to teaching of persons of maturer age from other professions should be made possible. Maintenance allowances should be given in addition to family allowances to enable children to stay at school until they are eighteen, and in modern schools sixth forms or their equivalent should be developed to provide pupils between sixteen and eighteen with an education which will qualify them for admission to a training college or a university. All types of secondary schools should see that the claims, conditions and prospects of the teaching profession are adequately presented to their older children. The fact that bad buildings and large classes are the greatest deterrent to recruitment should be realized. The marriage bar should be removed. The rules which prevent teachers from playing a part in public life should be relaxed, and schools should be so staffed that the presence of all teachers all the time should not be regarded as a necessary condition of effective work. Special arrangements should be made to meet the needs of married women, and the use of part-time teachers should be encouraged. The esteem in which the education service is held should be improved, so that it may become attractive to intelligent and cultured men and women. High public esteem being an obvious factor in recruitment, parents and others should be given the opportunity of learning about the new educational system.

The foregoing summary statement, every item of which is fully elaborated in the report, is enough to illustrate the painstaking thoroughness with which the Committee has handled this essential part of its work. But as the reader turns the pages devoted to these excellent suggestions, there inevitably lurks in his mind the difficulties of persons who may feel attracted to the teaching profession, but who under present arrangements simply cannot afford to yield to the attraction, and therefore seek other openings. A missionary spirit, the Committee reminds us, cannot be relied upon to maintain the supply and the morale of a quarter of a million teachers. "Teaching is indeed a form of social service, but like other professions it is also a bread and butter affair." A comparison is drawn between the salaries earned by teachers and by Civil servants of comparable grades. It is found that in a large provincial town a certificated teacher has a maximum, after allowing for pension deductions, which is £162 less than the maximum salary of a junior executive officer in the Civil Service, in spite of the extra years spent in a training college or university. The Committee recommends a substantial increase in the salaries of teachers, the present scales being often insufficient for personal needs and family responsibilities, and therefore inadequate to attract teachers of the quality and quantity required. It holds also that the present scales differentiate unfairly between elementary and secondary schools. It recommends a single basic scale for all teachers in primary and secondary schools, with additions for special qualifications or special responsibilities. The Committee's final word on the subject will often be quoted: "we have not yet emancipated ourselves from the tradition of educating our children on the cheap".

The Committee takes the bold course of recommending the abolition of the time-honoured distinction, applicable only to elementary school teachers, between the certificated and the uncertificated. Instead, the Board should recognize only one grade of teacher in both primary and secondary schools, the "qualified teacher", that is, normally one who has satisfactorily completed an approved course of education and training. The normal course in training colleges should be extended from two to three years, with one term of continuous practice in a selected school. An essential element at this stage, the report wisely adds, is a reasonable amount of leisure and a personal choice in the use of it. There should be an accessible college or centre devoting special attention to the education and training of teachers of art and crafts, music, physical education and domestic subjects. The same kind of facility should be provided for students desiring to take part of their training in an institution in a rural area. Training facilities should also be within reach of teachers preparing to take up work with young children and with handicapped children in special schools.

We now come to the big problem of general organization. The Committee agrees that the Board of Education should now assume the obligation of ensuring that training institutions adequate in number and quality are available, and are fused into a national system. We may remark, incidentally, that such an obligation rests upon the Board in respect of schools, but that in respect of training colleges it is an entirely new thing. To secure this end, the Committee considers that two constitutional changes are necessary: (1) the formation by the President of the Board of a small central training council, and (2) the close integration of all training institutions and interests on a convenient area basis.

Thus far the Committee is unanimous; but at this point it splits into the two equal groups to which we have referred. It is divided in opinion as to the areas. It may be useful here to explain that fifteen years ago a very important change was made in the examination of students in training colleges

and the consequent award of certificates. Up to that time, the examination had been conducted by the Board of Education, preceded by the old Education Department. It was widely held to be an out-of-date arrangement that had come down from the time of Kay-Shuttleworth. Indeed, one important exception had already been made, by which a training college, the largest in England, opened in 1905, and owned and controlled by a university, was never examined by the Board, but by the university—the Board, of course, having the final word as the awarder of its certificates. By the change made fifteen years ago, this arrangement was generalized. The universities (with the exception of Oxford), at the request of the Board of Education, took over the responsibility for the testing and examination of students. Each university, and the training colleges more or less grouped round it, formed a Joint Board, responsible for the appointment of external examiners and for the conduct of examinations. We may remark in passing that the examination for the teacher's certificate thus became partly internal instead of purely external. The Joint Boards thus constituted exist to this day. Five members of the Committee recommend that the Joint Boards should be abolished, and that each university should establish a "University School of Education", to which training colleges should be affiliated. The other five recommend that the Joint Board scheme, instead of being abolished, should be developed and strengthened.

Obviously the main difference between the two schemes lies in the part which should be played by the universities in the training of teachers. To say, at once, as *The Times* has said, that there "appears little doubt" that the scheme which makes the universities responsible is preferable is, we suggest, scarcely to do justice to the case presented by the other side. If the Joint Boards have "failed to promote real co-ordination, except in the matter of examinations", it must be remembered, not only that the reform of the examination system was the reason for their creation, but also that the universities, as the predominant partners, must bear most of the blame for the alleged failure to utilize a great opportunity. The five advocates of the Joint Board scheme appear to us to be quite as keenly aware as their five colleagues of the shortcomings of the existing Joint Boards, and what they really advocate amounts almost to a new scheme under the old name. No one should make up his mind on the subject without carefully weighing their arguments. On the face of it, the President of the Board is now asked to adopt one scheme and set aside the other. He will have many counsellors to consider besides the ten members of the McNair Committee, and it would not surprise us if, with his genius for compromise, he devises a plan which, while not placing responsibility at once upon the universities, would be a possible step in that direction. Fifteen years ago, as many will remember, the universities had thrust upon them a responsibility which most of them did not by any means desire. The promise of a successful enterprise was not there from the first. It remains to be seen how far they are convinced by the case for university responsibility put forward by one half of this Committee.

Many other points in the report deserve more comment than can be made here. The system under which earmarked grants are made to students who sign a declaration or 'pledge' that they intend to become teachers is condemned. So also is the system of loans to students—another form of bribery to enter an ill-rewarded profession. Again, the conditions in many training colleges are reported as needing drastic improvement. Nearly two thousand students in training colleges sleep in cubicles rather than in bedrooms or study-bedrooms. In some cases the training colleges impose discipline on their students which is obsolete and unsuitable. Unless, adds the Committee, students are allowed more freedom, they cannot be expected to acquire that sense of responsibility essential to teachers.

One further matter calls for special comment. We refer to the strong line taken by the Committee in the matter of speech training. Unless, the Committee says, a teacher has at least a moderate competence in reading, writing, speaking and listening, he is hampered at every turn. We agree, and we must add that thereby hangs a tale. So long as the Education Department or Board of Education conducted the examinations, every outgoing student in a training college stood up and read or recited to the inspector, during his annual visit, and he was trained to meet this ordeal. When the Board ceased to examine, this salutary practice also ceased. Again, when the secondary school became the normal avenue of access to the training college, the change from the old pupil-teacher system, though entirely admirable in every other way, did no good to the cause of clear speech in the training college, for reasons which the Norwood Report has made abundantly clear. One can therefore quite understand that the position in training colleges on this vital matter has gone steadily from bad to worse. Is it too much to say that the ultimate responsibility for this sad deterioration lies with the universities, where the finest of scholars are sometimes the worst of speakers and therefore the worst of lecturers, and are thought none the less efficient on that account? Teachers and preachers and actors and politicians, all maybe educated at universities, have had to rely upon their natural gift of speech, which may be good or bad or indifferent. So far as teachers are concerned, the recommendation of the McNair Report is clear and emphatic. It recommends "that the Board of Education should require every training institution to pay attention to the speech of every student, and every area training authority to include in the assessment of a student's practical teaching the ability to use the English language". It further recommends "that the Board of Education should require every training institution to make arrangements for the detection of speech disabilities and for the provision of speech-therapy and training where necessary". This call for assistance from a new but ably cultivated branch of science will not go unanswered; and nothing but beneficial effects will be achieved.

RACIAL DISCRIMINATION

Man's Most Dangerous Myth

The Fallacy of Race. By M. F. Ashley Montagu. Pp. xii+216. (New York: Columbia University Press; London: Oxford University Press, 1942.) 15*s*. 6*d*. net.

THE author's thesis is that experience rather than inborn traits determines standards of social conduct, that most so-called lower-grade human types would reach high standards in this respect if given opportunities, that we must not assume standards other than our own to be necessarily inferior but must allow that adaptations in diverse environments give rise to different standards, and that outbreeding promotes vigour. He therefore condemns racial discrimination, especially in the U.S.A., and urges a policy of social amelioration and education, looking to the lowering of racial barriers and to implementing the first principle of the American Declaration of Independence. Race discrimination has, in any event, failed to prevent widespread mixture. He sees the human individual as the developed result of a bundle of genes of many origins, the bundle re-sorting itself in the development of every child. He might perhaps have gone further in this direction by acknowledging that *genes* are hypothetical, even though the gene hypothesis has more in it than the race hypothesis.

The race hypothesis, as commonly put forward, presupposes the segregation of parts of an original human group into separate groups with divergent modifications. It then makes a classification on the basis of skin colour and hair texture, and lumps together all the people with dark skins and kinky hair as though they had branched off from the rest of humanity as a unit and had had a subsequent history of their own. But even Ashley Montagu scarcely sees how improbable that racist view is. Archæology tells us of drifts of men at various very early times in various directions into Western Europe, East and South Africa, India and the East Indies and so on. We seem to find cranial characteristics, which were common, but not universal, among men of certain phases of the Old Stone Age, now exhibited among people from various remote areas in Europe, Africa, and south-east Asia and Australia. But the people who show these cranial characters are white, yellow-brown, dark brown or almost black and have wavy hair or kinky hair, all largely according to the region they inhabit. One must have regard to hypotheses that race drifts with diverse cranial characters, and also social standards, spreading in Europe, Asia and Africa, nearly all have regional characters of pigmentation and hair texture impressed on them. This strongly suggests that the idea of *one* African race with a mainly separate history from its inception is artificial in the extreme; as indeed, Ashley Montagu says, all systems of racial classification must be. Different characteristics have different kinds of histories, mostly still very imperfectly understood, but it is a first step to better understanding to realize that the growth of our physical features is the result of a combination of innate and environmental influences that are tangled up beyond possibility of separation; and that we cannot consider an individual as one unit of inheritance—we are all gatherings of fragments.

Why is it that race prejudice is so powerful? We are typically concerned to maintain our social standards, most of all perhaps to see that our daughters do not drop to lower social grades when they marry. Now the assessment of social grade is a complex affair; but, when, as in the southern parts of the United States, the lower grades are often those made up largely of coloured people, it becomes easy to transfer the prejudice from 'low grade' to 'coloured', and analogous transfer has occurred in the case of the Jews of Central Europe on the basis of other physical characters, among the Bantu of South Africa and many another group. The facts that it has not occurred appreciably among the Maori and that it is less marked in Latin- than in English-speaking America are of outstanding importance, and are to be accounted for on very different lines in these two cases.

We know very well in this twentieth century that several of the outstanding personalities of the world have other than white skins, even though it has been the white-skinned people who have on the whole set the general standard in the nineteenth century by which distinction is reckoned. The white man owes his superiority largely to his invention of devices for mechanical power in industry and to his development of medical science. Whether that standard will survive, with the spread of machinery to Asia and Africa, and the crisis of reproductivity that is so widespread in north-west Europe, remains to be seen.

In any event, it is becoming not only wrong but also excessively stupid to hold men down to menial positions and to subject them to indignities because of skin-colour. We can all think instantly of individual after individual whose value to humanity forces respect even from the prejudiced white man, and who carries the scars of past and sometimes present ostracism. Ashley Montagu points out how harmful this is to both the coloured man and the white, and pleads for education, accompanying a real recognition of membership of humanity, and a forthright condemnation of the racism of Henry Fairfield Osborn, Madison Grant, Houston Stewart Chamberlain, and the Nazis in Europe. There is no evidence for general physiological harmfulness of inter-marriage of people with very diverse physical characters; there is only too much evidence of the social danger of inter-marriage between people of very diverse upbringing and social standards. It is true that very occasionally a physical heritage for one parent does not fit an adjacent heritage from the other parent; but this occurs in children of parents who belong to the same nation as well as in children who would commonly be considered to be of more hybrid make-up. In both it is a rare phenomenon.

Some mixtures also are probably very valuable if given a fair opportunity; it is, for example, said by some observers that Anglo-Chinese children tend to be very intelligent, while the vigour in several respects of the French Canadians with their tincture of indigenous American heritage has often been mentioned.

It is obvious that, with the best of intentions, we may use our influence and prestige unwisely if we seek to transplant our whole system among peoples of quite different experience. The British educational effort in India was for generations far too literary and so not able to touch the masses, besides producing disaffection among those who got a smattering of it. The idea of implanting a fully developed parliamentary system among peoples who have little tradition in that direction is another obvious source of trouble. The problems of inter-racial contacts are,

in fact, insoluble save by the softening influence of more contact, and by the wider recognition of our common humanity and of the white man's weaknesses as well as of his power to help. Consciousness of supposed superiority on one side and of impressed inferiority on the other are the bane of all relations between peoples of diverse traditions.

H. J. FLEURE.

IS THE MIND A CALCULATING MACHINE?

The Nature of Explanation

By Dr. K. J. W. Craik. Pp. viii+124. (Cambridge: At the University Press, 1943.) 6s. net.

AT a time when professional philosophers are trying to persuade us that philosophy is an attempt to answer questions which should never have been asked, and professional scientists are taking over the task of answering the questions, it is refreshing to come upon a writer on philosophy who, after a few preliminary skirmishes with the modern sceptics, unhesitatingly attacks a philosophical problem by the plain scientific method. Dr. Craik makes his philosophical point of view crystal clear. He believes in the methods of the observational scientists as the only methods of explanation. He is intolerant only of those who will not experiment and who consider that the virtue of thought is analytic precision rather than fruitfulness in the experimental field. He confesses that he has no gift for analytic precision and is particularly addicted to confusing similar concepts. He is, quite clearly, not deeply versed in traditional philosophy. This gives his book a certain freshness of outlook, although it makes his criticisms of the great philosophers, particularly Kant, appear rather naïve.

The first three chapters discuss five attitudes in which one might approach the question, "What is explanation?": (1) The *a priori* method consists in the logical deduction of conclusions from premises accepted as indubitable because the terms involved have been clearly and precisely defined. When coupled with empiricism, as sooner or later it must be, apriorism is transformed into (2) scepticism. (3) There is the view that explanation is merely description, which says nothing about causes. (4) There is the relational theory, which also insists that explanation has no interest in causes, its task being to find relations between observable entities. (5) There is finally the causal theory, which holds that explanation consists in discovering the actual interaction of things within the universe.

Although Dr. Craik is not clear on this point, he seems to consider it necessary to disprove the first four theories and to establish the causal theory before he formulates his theory of the nature of explanation. Apriorism is rejected because analytic certainty is an illusion. In attacking scepticism he insists that the assurance of an outer world is to be found not in any proof but in the fact that our symbolism works. The point could have been more convincingly established by showing that all usages of the word 'outer' in English have no relevance to the question "Is there an outer world?", and that in this context 'outer' is meaningless. Dr. Craik, however, in his justifiable hostility to the metaphysics of logical positivism, fails to grasp the importance of its linguistic analysis. Relational and descriptive theories such as those held by modern physicists, which associate definite probabilities with events and eschew any attempt to find an underlying causality, are rejected on the grounds that probability is meaningless without causality. Like symbolism, causality is accepted because it works.

This preliminary discussion paves the way for the main thesis, which can be stated as follows. The nature of thought is essentially prediction. Prediction consists in devising symbols to represent an external process, performing a mental operation upon those symbols, and then translating the result back again into an external situation. Calculating machines, A.A. predictors, do just this sort of thing, because in certain essential respects they parallel the external reality.

This is the hypothesis. The first question that presents itself is, "What corresponds in the mind to the mechanical parts and movements in the predictor or the calculating machine?" One answer, which the author does not consider, is that it is the symbols and the transformations which they undergo in accordance with logical principles. This is a perfectly intelligible view. It was put forward very clearly by the great American philosopher, C. S. Peirce, who states that reasoning consists in performing mental experiments upon symbols. the grouping of the symbols representing the arrangement of the facts so far as is necessary for the reasoning involved. In this connexion Peirce developed a system of logical graphs which in an abstractly pictorial way enable the premises of an argument to be represented and the conclusion read off. Dr. Craik, however, seeks his analogue for the calculating machine in the brain, and suggests that it is to be found in "neural patterns". Implication would then be the power of these neural patterns to act on each other as the real events act causally upon one another. He even suggests that a physiologist, if he could see these patterns in the living brain, might be able to interpret the ideas they represent and, presumably, though this is not stated, to follow the argument. This is difficult doctrine.

In a chapter entitled "Methods of Testing this Hypothesis", experiment with the view of establishing the meaning of words pragmatically is strongly urged; but it is difficult to see what relevance such experiment could have to a hypothesis about the brain. In the last few pages the truth emerges that it is the physiology and biochemistry of the brain that must be used to test the theory, and no experiments are suggested in these spheres.

The book, considered as a reasoned exposition of a single hypothesis, is not wholly successful, because the author has not presented the hypothesis in such a way as to make clear just how it can be confirmed or refuted by experiment. He seems quite unaware, for example, of the enormous leap he makes in the transition from symbols to neural patterns. There is compensation in the number of illuminating suggestions which are struck off like sparks in the course of the argument. There are two or three pages on the ethics of selfishness which are worth a volume of professional moralizing, and a valuable suggestion about the part played by feeling in the formation of hypotheses. Finally, to have an idea is, for Dr. Craik, to think of ways of testing it; and, for many incidental ideas on the fringe of the main argument, he makes ingenious suggestions about establishing or refuting their validity.

WINSTON H. F. BARNES.

EDUCATION AND THE COMMUNITY IN AFRICA

By PROF. DARYLL FORDE
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THE discrepancy between technological advance and social adaptation which is reflected in the crises and upheavals of the twentieth century is from many points of view the fundamental problem of our time. Although the economic and social problems of Africa may seem less urgent and menacing than those of Europe, this discordance and the social disequilibrium that accompanies it are, in fact, developing in an extreme form. The very fact that in Africa indigenous techniques and social organization have been comparatively simple means that the gap to be bridged in the process of integration with the Western world is correspondingly great and the social transformation all the more far-reaching. The pace of technological and economic change is quickening every day, and the need to smooth the path of the inevitable transition from small-scale tribal communities to a self-sustaining social organization commensurate with a large-scale exchange economy becomes increasingly urgent. There is perhaps little appreciation that failure may involve at a later stage violent social upheavals and zenophobia on a continental scale. Where the inadequacies of the existing agencies for social development and the evils of socially disintegrative individualism are seen at close quarters by the administrator, the missionary or the educator, the problems are often formulated only in economic or ethical terms and as questions of administrative machinery. The opportunities and needs for guiding the development of the more general social framework to meet the technical and economic changes have hitherto received little consideration. The fact that the effectiveness of such guidance will necessarily depend on the amounts of human energy and resources that are devoted to the reconstruction of the social organization of African communities finds inadequate recognition.

It is little more than a generation since the African villager lived in a small, practically closed society in which status and obligations were determined by a network of local and personal relations. Farming and stock-raising required co-operation only with kinsmen and fellow villagers. Despite occasional and violent incursions from the vague outer world, religious and political concepts were, like economic values, bounded by a universe of a few thousand people. Even where centralized political institutions had created more considerable states, limitations on transport and division of labour left a high degree of autonomy to the local settlement group. The people in these small communities, knit together by a close web of inter-personal relations which guided and restrained their conduct at nearly every point, are all now being progressively affected by the rewards and demands of the world economy, and the regulations of an impersonal Western administration.

The old economic self-sufficiency of African communities is already a thing of the past. Even where direct production for local needs is still considerable, it is the new values associated with cash returns for crops and labour, market purchases of trade-goods, the achievement of new standards in dress and food and opportunities for learning new trades that are dominating the outlook of the energetic and progressive. One of the most significant social aspects of this process is the fact that Africans have so often been brought into the orbit of the outer world not as communities but as individuals. The migrant or permanently urbanized wage-labourer, the villager who sells his crop of maize, ground-nuts or palm oil for the external market, the hawker of cloth and hardware in village markets, and the middleman who buys up produce for the Western firms, all encounter and adapt themselves to the new economic opportunities and Western cultural values as individuals. There is at once a greater freedom for personal initiative in new fields and a weakening of effective control and support of the individual by the community. As the individual secures personal returns in an open market as well as a higher mobility and a widening choice of where and how to live, the old norms begin to lose their validity and the community itself to disintegrate. But new standards and a new social framework are slow to emerge. There is instead a trend towards detribalization into amorphous aggregations shot through with new forms of individual competitiveness that are often restrained only by the external authority of the European administrative system. Unless the new occupations, rewards and demands are linked to social forms which can both ensure group benefits and security and harness individual effort to social ends, the period of adjustment from the old tribal life to a social equilibrium consistent with the new economies will be marred by social conflict, with waste of both human capacities and material resources.

The basic sociological principles underlying satisfactory adaptation to such rapid changes are not recondite. There is in the first place the need for attaching new functions and techniques to existing social structures, which are themselves concurrently adapted so that they do not become functionless and obstructive. By this means, the activities of the more capable and energetic who are in the vanguard of economic change do not become independent of the salutary restraints of group standards, with a significant loss of social solidarity.

Secondly, there is need for the progressive integration of the small-scale groups, appropriate to the earlier less complex economy, into larger and more comprehensive groups. Since the pattern of small groups, with their corporate sense and will to survive, already exists, economic change may easily lead to internecine struggles for dominance among them—struggles which result not only in loss of well-being and security by the unsuccessful but also in a less efficient, because economically less productive, transition to a new social pattern. The problem therefore resolves itself into securing progressively higher levels of group organization to which the loyalties and sense of interest attached to existing small groups is in part transferred. Intensification of faction within communities and jealous rivalry between them are typical social reactions to economic change where there is little grasp of the nature and long-term effects of the forces involved, and they can be reduced only by policies designed to promote understanding of the forces at work, and behaviour that is adjusted to new economic organization. This involves not merely education in the formal sense, but also the enlightening of the adult population and especially the leaders, traditional and newly arrived, concerning the technical and economic conditions of their lives.

These are among the main issues underlying the

recent report on Mass Education in African Society by a Sub-Committee of the Advisory Committee on Education in the Colonies*, which rightly puts the active participation of the community in education proper and also in all projects for social development as the first requirement for satisfactory development under rapidly changing conditions. It comments acutely on a changing attitude towards economic disabilities or misfortunes, noting a growing attitude which tends to exaggerate the direct responsibility of groups or individuals, especially those in authority, for all such happenings. Both the suspicion of economic exploitation and the growth of political aspirations, as well as the often vague but far-reaching sense of participation in a common struggle during the War which confers common rights in the economic and political organization of the future, require constructive measures to avert narrowly nationalistic demands. The report recognizes that the need for combining effective guidance with the evocation of leadership from among the people themselves involves the co-ordination of many diverse agencies, which will, as is shown, prove no easy task. On one hand, members of the administration, education departments, technical services, missions and African churches must be welded into co-operating teams, subordinating their sectional or professional interests and prestige to the common objective of securing the greatest confidence and enlisting the fullest participation of the people themselves. For it is the widened experience and capacity for judgment which such participation can give that an educational programme should seek to provide. Only on such a basis will sustained effort and wise leadership be forthcoming from the African communities themselves. It presupposes, as the report points out, objectives with which the people can readily identify themselves, and while there must be provision for freedom of discussion and criticism, "there must be opportunity for extending the range of knowledge relevant to the changing conditions. Full discussion in itself is valuable, but it is not a substitute for being well informed".

The mass education programme is summed up as an effort to provide this experience and at the same time to "call out the ability and the will to share in the direction and control of the social, economic and political forces" by means of a co-ordinated effort of both official and unofficial agencies which will link up all development and welfare plans with community education, setting specific targets and attempting to imbue all groups and persons in the community with a sense of common effort and advantage. From some points of view the term 'mass education' as applied to such a programme is unfortunate. The objective is in fact the reverse of mass treatment. An articulate and appropriately differentiated community is the goal. The approach needs to be based in every case on the particular needs and opportunities in the given community and the activities of different persons and groups adjusted to their special functions, actual or potential. While the rapid promotion of literacy is an important aim, it is properly regarded as but the means to general advancement. The measures envisaged would not herd masses of adults into classes merely for reading and writing. It is community education in the widest sense that is urged; and that term, rather than one which suggests undifferentiated handling by uniform means, better expresses both the aims and the methods to be employed.

In framing the programme for any community, 'sociological mapping', together with a definition of the major obstacles to social and especially economic progress, which could provide the focus of public interest for an educational campaign, are held to be prerequisite. It is also urged that every advantage should be taken of existing educational agencies, formal and informal, and every attempt made to enlist the co-operation of indigenous organizations. In this connexion the point might well have been made that the very process of associating diverse organizations in a comprehensive scheme should have considerable educational value in promoting an awareness of social forces and a capacity to consider social organization in terms of practical needs. Organizations, whether indigenous or implanted, from secret societies and age-sets to mission units and village councils, will tend to be judged according to the service they can render. The need for preliminary survey whereby those in charge can secure a sound grasp of the social structure of the community in question is repeatedly emphasized: "however good the content of a mass education plan and its technique may be, it cannot hope to be successful unless it is carried out by people who know their society and its significant sociological forms and how they are changing under modern conditions". An essential point in the suggested organization is the appointment of "Mass Education Officers" to co-ordinate and supervise the work in any one area. Although not recruited from any one source, they will need training, as well as flair and interest, for understanding and securing the co-operation of the community in each project, and then guiding the development to promote social cohesion and welfare.

This point is perhaps one which needs particular attention, since it is but one instance of a growing need for investigators and executants with sociological training, for which there is at present only the most meagre provision in British educational institutions. The notion that training is required for independent and empirical inquiry into social structures and the forces that sustain them, and even that such inquiries are pre-requisite for intelligent control of social development, has yet to make its way. The relevance of sociological theory and field methods to the practical problems of politics and social development finds little recognition. A sense of history, a sound ethical code and a fair mind, on which the British traditions of public administration and social reform insist, are no doubt admirable qualities, but they do not dispense with the need for methodological safeguards against misconceptions and unconscious prejudice, or for the application of scientific knowledge of social processes. Our engineers and medical men are expensively trained to acquire a body of tested principle, a capacity for diagnosis and the ability to apply their knowledge to particular problems. Sociological principles and methods are left to filter indirectly and belatedly into our educational system. In questions of social policy, standards of careful investigation and logical analysis are often lacking. The accelerated pace of social change in colonial dependencies, involving as it does many societies generically distinct in type, is focusing attention on this need in a field in which the social anthropologists have already pioneered; but sociological training and research will have to be further developed on a very considerable scale if recommendations such as those of this report are to be implemented.

* Colonial Office: Advisory Committee on Education in the Colonies. Mass Education in African Society. (Colonial No. 186.) Pp. 64. (London: H.M. Stationery Office, 1944.) 1s. net.

WÖHLER'S 'SYNTHETIC' UREA AND THE REJECTION OF VITALISM: A CHEMICAL LEGEND

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THAT Wöhler synthetized urea in 1828 and thereby rang the death-knell of vitalism in organic chemistry seems to be as firmly established a legend as that Galileo let fall at one and the same time from the leaning tower at Pisa two unequal weights, the thud of the simultaneous arrival of which upon the ground rang out the old Aristotelianism and rang in the new mechanics. But, as in the earlier, so in the later case, the facts are otherwise: there was no synthesis of urea, and chemists continued to assert the existence of vital force and to describe its role in the formation of organic substances. Wöhler's experiments have, however, acquired an altogether inexplicable and widespread significance, both in text-books and in popular scientific works, especially among those whose statements show that they cannot possibly have referred to his own account of them.

Wöhler published his memoir, "Ueber künstliche Bildung des Harnstoffs", in 1828[1]. We can scarcely call it well-known, because of the wide difference between what it contains and what its contents are now commonly believed to imply. In it Wöhler began by stating that he had returned to the study of the white crystalline substance that he had previously reported to be one of the products of the reaction between cyanogen and 'liquid ammonia' (that is, aqueous ammonia). This substance, as he had already pointed out, was produced also when one tried to combine cyanic acid with ammonia by double decomposition. It was more easily obtained either by the reaction between silver cyanate and a solution of sal ammoniac or by that between lead cyanate and 'liquid ammonia'. It was the product of the last reaction that was used for the experiments now reported by Wöhler. In the process of purification, the white crystalline substance appeared to give rise to a new product, which proved to be urea. Urea was, therefore, a compound of ammonia and cyanic acid; and an organic substance, in fact an animal substance, appeared to have been produced from inorganic materials. At that time, the cyanates were regarded as inorganic—of which more will be said later.

It was clear that the new substance was not an ammonium salt, as it yielded no ammonia with potash or with lime; and it no longer behaved as a cyanate on the addition of acids, nor did it precipitate lead or silver salts. Therefore, it contained neither ammonia nor cyanic acid: it was not ammonium cyanate. It possibly resembled a salifiable vegetable base. It behaved indifferently with acids, except nitric acid, the addition of which to a concentrated solution of the new substance gave a precipitate of shining scales, purification of which showed them to be so acid in character that Wöhler almost concluded that he had obtained a particular acid ("eine eigenthümliche Säure"), until he found that on neutralization with bases they gave nitrates from which the original substance could be separated by means of alcohol with all the properties that it had before the action of nitric acid. Comparative experiments with pure urea from urine showed that urea and the new substance were identical.

Prout's analysis of urea, Wöhler pointed out, closely corresponded with calculation from his own formula for ammonium cyanate together with an 'atom' of water. So, before discovering the formation of urea by cyanic acid and ammonia, it was possible to calculate in advance that ammonium cyanate with an 'atom' of water had the same composition as urea. Combustion of cyanic acid (by means of copper oxide) gave 2 volumes of carbonic acid and 1 volume of azote (nitrogen); but the combustion of ammonium cyanate should give equal volumes of these gases, which was what Prout found for the combustion of urea. Wöhler stated, in conclusion, that he refrained from all considerations on the subject of compounds of the same composition with very different properties, such as were already recognized in the case of fulminic acid and cyanic acid, and of "liquid carbonated hydrogen" and olefiant gas.

So ended this now famous paper, the contents of which, it will be seen, bear little relation to what is widely current about it. It contains nothing to justify any of the *décors* of death-knells and so on. Contemporary versions of it appeared in French[2] and in English[3]. They were careful and exact. The French version was a full and unexceptionable translation, including even the correction of a numerical error in the addition of the analytical data quoted from Prout. The English version was more in the nature of a detailed abstract, omitted nothing important, and was substantially complete.

Wöhler, therefore, records no synthesis; for by synthesis we mean the compounding of a substance from the elements that compose it. Cyanogen had not been synthetized at that time. The source and method of preparation of the cyanates are therefore of interest here. Organic matter, such as dried blood, hoofs, horns and so on, was heated with potash and iron; the resulting mass, on extraction with water, gave 'ferrocyanate of potash' (potassium ferrocyanide), from which by the action of heat there was obtained 'cyanuret of potassium' (potassium cyanide), which on oxidation gave the cyanate[4]. Among the hoofs, the cloven one of vitalism is surely not difficult to detect here (or in the 'liquid ammonia').

Wöhler wrote to Berzelius from Berlin on February 22, 1828, about these experiments and their curious results, saying that he could make urea without a kidney or a living creature, be it man or dog: ". . . ich Harnstoff machen kann, ohne dazu Nieren oder überhaupt ein Thier, sey es Mensch oder Hund, nöthig zu haben"[5]. Without a kidney or a living creature, man or dog: but, be it noted, not without dried blood, horns, hoofs, and such "organic" originals.

Yet Wöhler recognized in this very letter that the production of an organic substance from inorganic materials, or, as we should say, from non-living sources, turned on the question of the carbon used:

"Diese künstliche Bildung von Harnstoff, kann man sie als ein Beispiel von Bildung einer organischen Substanz aus unorganischen Stoffen betrachten? Es ist auffallend, dass man zur Hervorbringung von Cyansäure (und auch von Ammoniak) immer doch ursprünglich eine organische Substanz haben muss, und ein Naturphilosoph würde sagen, dass sowohl aus der thierischen Kohle, als auch aus den daraus gebildeten Cyanverbindungen, das Organische noch nicht verschwunden, und daher immer noch ein organischer Körper daraus wieder hervorzubringen ist"[6].

From Stockholm Berzelius replied on March 7, 1828, whetting his Rabelaisian wit upon the moderate and guarded claims of his devoted pupil and correspondent:

"Nachdem man seine Unsterblichkeit beim Urin angefangen hat, ist wohl aller Grund vorhanden, die Himmelfahrt in demselben Gegenstand zu vollenden, —und wahrlich, Hr. Doktor hat wirklich die Kunst erfunden, den Richtung zu einem unsterblichen Namen zu gehen. Aluminium[7] und künstlicher Harnstoff, freilich zwei sehr verschiedene Sachen, die so dicht aufeinander folgen, werden, mein Herr! als Edelsteine in Ihren Lorbeerkranz eingeflochten werden, und sollte die Quantität des artificiellen nicht genügen, so kann man leicht mit ein wenig aus dem Nachttopf supplieren. Sollte es nun gelingen, noch etwas weiter im Produktionsvermögen zu kommen (vesiculae seminales liegen ja weiter nach vorn als die Urinblase), welche herrliche Kunst, im Laboratorium der Gewerbeschule ein noch so kleines Kind zu machen.—Wer weiss? Es dürfte leicht genug gehen.—Aber nun genug mit Raillerie, besonders da ich es so eilig habe, nur Verständiges im Jahresbericht zu schreiben. Es ist eine recht wichtige und hübsche Entdeckung, die Hr. Doktor gemacht hat, und es machte mir ein ganz unbeschreibliches Vergnügen, davon zu hören. Es ist ein ganz sonderbarer Umstand, dass die Salznatur so vollständig verschwindet, wenn die Säure und das Ammoniak sich vereinigen, was für künstige Theorien sicher sehr aufklarend sein wird. . . ."[8].

Berzelius would not appear to have sensed any refutation of vitalistic belief here, nor in fact is there any: to regard the cyanates as inorganic substances was a mere item of code, especially in view of what has already been pointed out above about their mode of preparation; and, in any event, Wöhler had effected a transformation, not a synthesis.

Consideration of syntheses, real or imaginary, merely from the point of view of their significance for or against vitalistic theory, is not the most profitable historical study. Compounds other than those of carbon, for example, water and ammonia, might have to be considered; and among the carbon compounds themselves carbon dioxide might easily claim very serious consideration, above all things as the great medium between 'dead' and 'living' carbon. Logicians would probably seize on the very objection foreseen by Wöhler, namely, the necessity of knowing the pre-history of the carbon used in the crucial synthesis; and the geologists would not be prepared to vouch even for diamond as derived from 'non-living' origins. But chemists happily are not mere logicians; and it is of some interest for us to consider what organic substance was first synthetized (that is, compounded from its elements), the term 'organic substance' being used in the sense of an organic compound more complex than carbon dioxide occurring in, or produced by, living organisms. For this we must, it seems, turn to the synthesis of acetic acid by Wöhler's pupil, Kolbe.

In his historic memoir, "Beiträge zur Kenntniss der gepaarten Verbindungen"[9], Kolbe dealt with chloracetic acid towards the end[10] of his long discussion of copulated compounds. Using modern nomenclature and formulæ, we may readily summarize his work on this point. Carbon disulphide (made by heating charcoal and sulphur) reacted with chlorine to give tetrachlormethane, which, when passed as vapour through a red-hot tube, gave chlorine and tetrachlorethylene, which, in sunlight in the presence of water (and the free chlorine), gave trichloracetic acid. Melsens had shown a year earlier[11] that trichloracetic acid could be reduced to acetic acid by potassium amalgam. Thus the synthesis of acetic acid was complete. It was the achievement of Kolbe in 1845; it was the first organic substance to be synthetized; and it will soon be a hundred years since this notable work was published.

$$C + S \rightarrow CS_2 \rightarrow CCl_4$$

$$2CCl_4 \xrightarrow{\text{vapour in red-hot tube}} C_2Cl_4 + 2Cl_2$$

$$C_2Cl_4 + Cl_2 + 2H_2O \xrightarrow{\text{sunlight}} CCl_3COOH + 3HCl$$

$$CCl_3COOH \xrightarrow{H} CH_3COOH.$$

Those who are further interested in these matters may feel that both urea and acetic acid are what are called 'degradation' products of the living organism, but here we are content to have made some attempt to lay the legend of Wöhler's 'synthesis'. To most chemists, the facts seem to be known: they were taught to me as an undergraduate by Norman Collie, and it is clear that undergraduates at Manchester were also taught the true facts of the matter by Schorlemmer in the last century[12].

But what of vitalism after Wöhler's memoir of 1828? A study of the literature shows that Wöhler's experiments had no such result as they are now commonly credited with. In the 1840's, Berzelius, Wöhler's own teacher, then about to leave the scene of his prodigious chemical labours, and Gerhardt, at the zenith of his brilliant re-ordering of organic chemistry, both expressed their belief in the existence of a vital force in the formation of organic substances. In Berzelius's great treatise, in fact in the posthumous edition edited by Wöhler, he wrote:

"Dans la nature vivante, les éléments paraissent obéir à des lois tout autres que dans la nature inorganique; les produits qui résultent de l'action réciproque de ces éléments, diffèrent donc de ceux que nous présente la nature inorganique. Si l'on parvenait à découvrir la cause de cette différence, on aurait la clef de la théorie de la chimie organique. Mais cette théorie est tellement abstruse, que nous n'avons aucun espoir de la découvrir, du moins quant à présent. Néanmoins nous devons faire des efforts pour en approcher; car nous finirons par y arriver, ou bien nous serons arrêtés à une limite que nos investigations ne sauraient dépasser . . . l'essence du corps vivant ne repose pas sur ses éléments inorganiques, mais sur quelque autre principe, qui porte les éléments inorganiques communs à tous les corps vivants à coopérer à la production d'un résultat particulier, déterminé et différent pour chaque espèce.

"Ce principe (que nous désignons par le nom de *force vitale* ou *assimilatrice*) n'est pas inhérent aux éléments inorganiques, et ne constitue pas une de leurs propriétés primordiales, telle que la pesanteur, l'impénétrabilité, la polarité électrique, etc.; mais nous ne saurions concevoir en quoi il consiste, comment il prend naissance, comment il finit. Nous pouvons donc prévoir que si le globe terrestre existait avec ses éléments inorganiques, sans la nature vivante, mais du reste dans les mêmes circonstances, il continuerait à subsister sans êtres organisés. Une force incompréhensible, étrangère à la nature morte, a introduit ce principe dans la masse inorganique . . ."[13].

This was followed by a long and highly teleological comment. The ideas expounded by Berzelius on this problem have recently been described by Delacre as "presque un cours de morale"[14]. From our present point of view, we can at least surely say that those who believe that Wöhler drove vitalism out of organic chemistry will believe anything.

Gerhardt was at even greater pains to make his views on this matter clear and precise. In the summary of his classic memoir, "Recherches sur la classification chimique des substances organiques", read to the Paris Academy of Sciences in 1842, he said:

"J'y démontre que le chimiste fait tout l'opposé de la nature vivante; qu'il brûle, détruit, opère par analyse; que la force vitale seule opère par synthèse; qu'elle reconstruit l'édifice abattu par les forces chimiques"[15].

In the full-dress version of this, his most famous memoir, Gerhardt pictured all "êtres organisés vivants" as subject to two opposing forces, vital force and chemical affinity, normally in a state of dynamical equilibrium. He wrote:

"Si cet état d'équilibre était durable, si l'agent vital n'était jamais vaincu par les forces chimiques, on ne sait trop quelle serait la destinée des êtres organisés; mais sans doute alors la mort serait impossible, puisque la mort est précisément la cessation de toute résistance de la part de l'organisme contre les influences chimiques"[16].

The equilibrium is not abruptly upset: disease produces abnormal conditions locally and leads to the triumph of the chemical forces and the death of the organism. The action of the chemical forces on the organism leads to the production of carbonic acid, water, urea, and so on, but these are products of decomposition; and it is precisely these originals that the vital force acts upon in the contrary sense to build up blood and brain matter in animals, and wood fibres in plants. Gerhardt, indeed, held that the chemist could no more succeed in this re-building than the alchemist could attain an aim that seems less difficult:

"En présence de ces belles découvertes et de tout d'autres dont la chimie organique s'est enrichie depuis ces dernières années, celui qui ne considérerait que le fait de la reproduction artificielle, sans avoir connaissance des procédés, serait presque tenté d'attribuer au chimiste un pouvoir surnaturel, un pouvoir magique. A le voir ainsi enfanter, dans ses cornues et ses creusets, les créations de la nature vivante, pourquoi, en effet, ne lui accorderait-on pas la puissance de transmuter les métaux et de faire de l'or, ce qui semble cependant moins difficile? Une observateur superficiel pourrait seul se bercer de ce fol espoir"[17].

The chemist had never regenerated uric acid from urea, sugar from alcohol, and so on; and he would ever lack that power. Here Gerhardt repeated the assertion that he had made before the Academy and which I have quoted above: "La force vitale seule opère par synthèse". He went on to imagine an immense scale or ladder of organic substances. At its summit were such complex substances as the matter of the brain, blood, and so on; at its base, the much simpler substances, water, carbonic acid, urea, into which those more complex substances higher in the scale were decomposed by the action of chemical affinity, whereas, by the action of vital force, the simpler substances were again built up into the more complex.

Yet, when Wöhler died in 1882 and Hofmann prepared an account of his work, history had already begun to be written backwards as if it, too, were a 'reversible' process; and Hofmann spoke of Wöhler's 'synthesis' of urea as "an epoch-making discovery in the real sense of that word", explaining that chemists could scarcely realize the impression that the building up of urea from its elements ("aus seinen Elementen"!) then made on men's minds nor could they "conceive the feeling of joy with which the gospel of a new unified chemistry was hailed by the intellect of that time":

"Die Synthese des Harnstoffs ist im eigentlichen Sinne des Wortes eine epochemachende Entdeckung. Mit ihr war der Forschung ein neues Gebiet erschlossen, von welchem die Chemiker nicht zögerten Besitz zu ergreifen. Die heutige Generation . . . kann sich nur schwer in jene entfernten Zeiten zurückversetzen, denen das Zustandekommen einer organischen Verbindung im Körper der Pflanze oder des Thieres in geheimnissvoller Weise von der Lebenskraft bedingt erschien, und sie vermag sich daher auch kaum den Eindruck zu vergegenwärtigen, welchen der Aufbau des Harnstoffs aus seinen Elementen auf die Gemüther hervorbrachte . . . und man begreift daher den Jubel, mit welchem die Botschaft einer neuen einheitlichen Chemie von den Geistern begrüsst ward"[18].

It is difficult to make any comment on this extraordinary assertion; it appears to have been written without any sense of history or of restraint.

Vitalism in organic chemistry was rejected, not by any sudden and dramatic synthesis—for science does not advance and Nature does not reveal herself in that way—but by steady accumulation of contradictory fact: and in this field it seems remarkably odd that the professor of chemistry in Berlin should not have thought of that great chemist, great scholar and great Frenchman, Marcellin Berthelot, by whose discoveries, the earlier of which had been published more than twenty years previously, in 1860, in his classic "Chimie organique fondée sur la Synthêse", that rejection was ultimately achieved and from whom it unquestionably derives.

[1] *Pogg. Ann.*, **12**, 253–56 (1828). In 1812 John Davy obtained urea, but was unaware of it, by the action of ammonia and phosgene (*Phil. Trans.*, Pt. 1, 145–46; 1812); he gives no details as to the source of the carbon monoxide used in the preparation of the phosgene.

[2] *Ann. Chim.*, **37**, 330–34 (1828).

[3] *Quart. J. Sci.*, Pt. 1 (April–June), 491–92 (1828).

[4] The process is described in the almost contemporary text-book of Edward Turner, the first professor of chemistry in University College, London: "Ferrocyanate of potash" is "made on a large scale in the arts by igniting dried blood or other animal matters, such as hoofs and horns, with potash and iron. By the mutual reaction of these substances at a high temperature, ferrocyanuret of potassium, consisting of one equivalent of the radical of ferro-cyanic acid . . . and two equivalents of potassium, is generated. Such at least is inferred to be the product; for on digesting the residue in water, a solution of ferrocyanate of potash is obtained. . . . When heated to 212° F., or even below that temperature, each equivalent of the salt parts with three equivalents of water, leaving one equivalent of ferrocyanuret of potassium. . . . On heating the dry compound to full redness in close vessels, decomposition takes place, nitrogen gas is disengaged, and cyanuret of potassium mixed with carburet of iron remains in the retort." ("Elements of Chemistry, etc.", 3rd edn.. 658; London, 1831).

[5] Wallach, O., "Briefwechsel zwischen J. Berzelius und F. Wohler, etc.", i, 206 (Leipzig, 2 vols., 1901).

[6] Wallach, O., *op. cit.*, i, 208.

[7] Wohler had recently (1827) isolated aluminium.

[8] Wallach, O., *op. cit.*, i, 208–9.

[9] *Ann. Chem.*, **54**, 145 (1845).

[10] *Ann. Chem.*, **54**, 182 (1845).

[11] *Ann. Chim.*, iii, **10**, 233–37 (1844).

[12] Schloremmer, C., "The Rise and Development of Organic Chemistry", 195–96 (revised ed.; London, 1894).

[13] "Traité de chimie etc.", 2de. édn. française, trad. Hoefer et Esslinger, v. 1–3 (Paris, 1849).

[14] Delacre, M., "Histoire de la chimie", 372 (Paris, 1920).

[15] *C.R.*, **15**, 498 (Sept. 5, 1842).

[16] *Revue scientifique et industrielle . . . du docteur Quesneville*, **10**, 145 (Paris, 1842). I am pleased to express my thanks to the Curators of the Bodleian Library for their courtesy in allowing me to consult this volume.

[17] *ibid.*, 147.

[18] *Berichte d. deutsch. chem. Gesell.*, **15**, 3152–53 (1882). The quotations in English preceding the extract from Hofmann's notice are taken from T. E. Thorpe's "Essays in Historical Chemistry" 302–3 (2nd ed., London, 1902).

A NATIONAL ADVISORY SERVICE FOR AGRICULTURE AND HORTICULTURE

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In a statement in Parliament on January 20, dealing with the future of agricultural education, the Minister of Agriculture said that after careful consideration of the Luxmoore Report the Government has concluded that the provincial and county agricultural advisory services should be unified and combined into one national service for the whole country, directly under the Minister of Agriculture and financed wholly by the Exchequer. This statement, together with the publication of the Luxmoore Report, has concentrated attention on the organization and function of the existing agricultural advisory services and on how far the proposals of the Luxmoore Committee would strengthen and unify them. This subject was discussed at a recent meeting of the Association of Applied Biology, when Prof. W. B. Brierley was the principal speaker.

In the early stages of the development of agricultural education in England and Wales, most farmers regarded scientific agriculture with suspicion, and had little inclination to seek the help of technical advisers for the solution of farming problems. At first only formal courses of instruction for young people were available, and later lectures and demonstrations were provided for farmers. Prejudice hampered development and by 1908 only eight counties had appointed full-time agricultural organizers. In 1908 a departmental committee investigated the position of agricultural education in England and Wales, and recommended that each area the size of an average county should have a resident agricultural organizer to give instruction to farmers, to arrange field experiments, to lecture on their results and other matters of agricultural interest, and to act as director of agricultural education. Since then county agricultural staffs have been increased and now include instructors for crop production and animal husbandry, horticulture, dairying and poultry-keeping, who are well qualified to give advice on all practical difficulties. The county agricultural service has been controlled by the local county council and financed partly from rates and partly by the Ministry of Agriculture.

With the establishment of the Development Commission in 1909, money was made available for new developments in agricultural research and for the extension of advisory and teaching services. New research institutes were founded and financial assistance was given to those already in existence. In order that farming practice should be influenced by the extension of research work it was necessary to provide some bridge for the gap between the scientific work of the research institutes and the practical advisory work of county technical staffs. In 1911 it was decided to make annual payments from the Development Fund to certain universities and agricultural colleges to enable them to supply specialist advice to farmers and to provide for the investigation of local agricultural problems. This new specialist advisory service was organized on a provincial basis, and thirteen provinces covered England and Wales. The provincial advisory staffs were appointed, accommodated and administered by universities and agricultural colleges, which in return were allowed to call upon the advisers for a limited amount of teaching. The number of advisers varied with the demands of the provinces but usually included advisers in entomology, mycology, chemistry, economics and veterinary science. A memorandum of the Board of Agriculture ($A\frac{200}{1}$) defined the nature and scope of the two agricultural advisory services. Advice on such practical matters as the uses of artificial fertilizers, the relative merits of feeding stuffs for livestock and the manufacture of dairy produce should be given by the county staff. Advice on matters requiring special knowledge or special investigation should be given by the staffs of universities and agricultural colleges. County staffs were recommended to refer such problems to specialists and to consult the staffs of universities and colleges when their scientific knowledge and experience would be helpful.

In 1941 the Luxmoore Committee was appointed "to examine the present system of agricultural education in England and Wales, and to make recommendations for improving and developing it after the war". The Committee found that technical advice reached the farmer from two separate advisory services, the county service and the provincial service. The county advisory service possessed some men of outstanding ability and personality who with their staffs had given valuable assistance to the farming community especially in periods of depression and also during the war-time campaign to increase food production. The standard of the service, however, varied greatly and tended to be lower in counties where agriculture was the main industry. There were several causes for this: funds for agricultural education were generally smaller in agricultural counties where rateable values were low; local interests were occasionally detrimental to the development of the county advisory service, and in some counties those engaged in the agricultural industry had no sympathy with the science of agriculture and failed to appreciate the value of technical assistance. Occasionally members of the county agricultural service were used for purely administrative duties, and serious under-staffing made it impossible for them to maintain contact with more than a few farmers. The existence and functions of the provincial advisory service were not widely known. Provincial centres were controlled by either a chief advisory officer, a professor of agriculture, or the principal of an agricultural college. There was some lack of co-ordination between the advisory officers of a province, and at agricultural colleges there was little or no contact between the advisory officers and other scientific workers. Accommodation and equipment for advisory officers was frequently unsuitable and inadequate. It had been intended that the two services should co-operate in a relationship closely analogous to that between the general medical practitioner and the medical specialist; and that together the services should link agricultural research with farm practice, the provincial advisers having stronger affinities with research and the county staffs with practice. Co-operation was unorganized and in consequence varied greatly in different counties and provinces. In many cases the county advisory service had failed to make sufficient use of the provincial advisory service either because the county organizer did not recognize the problems calling for specialist advice or because the county service had become self-sufficient by the appointment of specialists to its

staff. In other cases provincial advisers had tended to usurp the functions of county organizers, or they were not sufficiently acquainted with agriculture to gain the confidence of practical men. Thus instead of a steady stream of ideas from the research institutes reaching the farmer through the provincial and county services as intended, the groups of workers associated with agriculture were linked loosely and haphazardly and, in some cases, not linked at all.

The Luxmoore Committee recognized the necessity for the continuation, improvement and extension of the agricultural advisory services and suggested that county and provincial services be combined into a national service. The aim of the proposed national advisory service would be to give every farmer easy access to the best practical and scientific information available. To achieve this the Committee suggested that each county should be divided into districts, their size to be determined either by the number of farmers or by the acreage of agricultural land. Each district should have a district officer whose duty would be to advise and help the farmers in his area. He should visit all the farms in his district at least once a year, arrange for meetings of farmers, demonstrations, lectures and discussions. A county organizer would direct and co-ordinate the work of the district officers, advise on local problems and where necessary forward them to specialist officers. In addition, the county organizer would have a staff of assistants qualified to give instruction and advice on such subjects as dairying, poultry-keeping, and the maintenance and repair of farm machinery. The specialist advisory service should be continued on a provincial basis, but in order to provide for a more comprehensive range of agricultural sciences it was suggested that the number of provinces should be reduced from thirteen to six and the staff appropriately increased. Specialist advisory officers should be scientific men with some practical experience of agriculture, and they should be allowed the freedom on which original thought and successful investigation depend. The co-ordination of the work of the specialist staff at the centre should be the responsibility of a chief advisory officer who should not himself be called upon to do advisory work. There should also be a provincial organizer to co-ordinate the work of the county organizers and their staffs throughout the province. A provincial administrator should be administrative head of both branches of the service and responsible for the office organization of the province.

The Association of Applied Biologists has many links with the advisory and research services in agriculture, and though members were agreed that the advisory services needed overhauling and re-organization, the proposals of the Luxmoore Committee received critical examination. An outstanding omission was lack of proposals for the co-ordination and integration of advisory and research services. It was obvious that the Luxmoore Committee was hampered by terms of reference that excluded the research service from the inquiry. The advisory and research services were essentially interdependent and the work of each provided stimulus to the other. The Luxmoore proposals would tend to isolate the two services and sever established relationships. The removal of specialist advisers from the university departments would isolate them from scientific contacts, and the transfer of advisory centres from the universities would lower the status of the specialists and weaken their ties with other scientific workers.

The provision of specialist advisers on a scientific basis was commented on, and it was suggested that recent developments in the sciences associated with agriculture necessitated widening the scope of the advisory services. Besides the advisers in entomology, mycology, chemistry, economics and veterinary science, there was need for advisers in such subjects as plant physiology, animal nutrition, virology, microbiology, helminthology. The Luxmoore proposals provided for advisers for all kinds of husbandry at the county level, and if suitably trained and experienced advisers were selected there should be no need for further specialist husbandry officers. Although the number of provincial centres would be reduced by the Luxmoore proposals, increases in personnel were suggested, and it should be possible to arrange that all branches of the agricultural sciences were represented. The provincial outstations, which were an integral part of the suggested provincial organization, might well be used as centres for additional specialists whose services would be available for the province. The enlarged provinces should offer better facilities for the training of new entrants to the specialist advisory service. The concentration of the specialist service at six provincial centres should make it possible to provide adequate accommodation and the necessary equipment of staff and apparatus for laboratory and field investigations. The advisory services had in the past been hampered by unsuitable accommodation and lack of facilities for their work.

It was noted that the organization of the advisory services as suggested by the Luxmoore Committee made no provision for the co-ordination of the work of specialist advisers in the particular sciences. The province would be a self-contained unit with no organized contacts beyond its boundaries. It was of great importance to all types of advisers that they should maintain contacts with advisers faced with similar problems in other provinces. Many of the major agricultural problems occurred in similar or related forms in several provinces, and interchange of experience, co-ordination of advisory and investigational work and arrangement of co-operative experiments should be possible. At present co-ordination of the work of entomologists and mycologists was achieved through the Plant Pathological Laboratory of the Ministry of Agriculture. Co-ordination of specialist investigations and advisory work might be obtained under the Luxmoore proposals if chief advisory officers were representative of various agricultural sciences and were charged with the responsibility of co-ordinating on a national scale the work in their respective sciences, in addition to co-ordinating the specialist work within their provinces.

Mr. Ronald Ede, secretary of the Luxmoore Committee, explained to the Association the permissive character of the present system of agricultural education and that the total expenditure of £600,000 for 1938–39 for all agricultural education and technical advice was quite inadequate for the needs of a basic industry like agriculture, the products of which were valued at £250 millions a year. The present county advisory system offered little chance of promotion and advancement except within the county and did not provide sufficient incentive for progressive young men. The establishment of a national advisory service would obviate some of the disadvantages occurring from the number and variety of responsible authorities, and its dependence on the national exchequer would ensure that all counties were served according to their needs and not according to their

financial resources. The proposed reduction in the number of provincial centres should allow greater numbers of specialists at each centre, and the development of out-stations of the provincial service should ensure that no part of the country was isolated from specialist assistance and that areas with special and distinctive needs would have necessary assistance. The provincial centres were to be established in university towns, though they would not be administered by the universities. The case for the integration of the existing advisory services into a comprehensive national service was strong. The agricultural industry would be better served by an organized and coordinated service, and greater opportunities for promotion and improved professional status would ensure that capable and energetic men entered the service.

OBITUARIES

Lieut.-Colonel Stanley Casson

BORN in 1889, Stanley Casson went from Merchant Taylors School to Lincoln College, Oxford, and held a senior scholarship at St. John's and a studentship at the British School of Archæology at Athens. In 1914 the War interrupted his studies, but he made good use of local opportunities in Macedonia and returned thither for excavation after the Armistice. During 1919–22 he was assistant-director of the School, and was elected in 1920 to a fellowship of New College, which combined opportunity for travel and research with a limited amount of lecturing under Prof. Percy Gardner, to whose philosophic outlook he owed much.

In 1924, Casson's historical geography of "Macedonia, Thrace and Illyria" won the Conington Prize, and after its publication in 1929 he produced a series of studies of Greek and modern sculpture—"The Technique of Early Greek Sculpture", "Some Modern Sculptors", "Twentieth Century Sculpture, and Artists at Work"—the result of much thought, observation and experiment in technique and equipment. In 1927 he was promoted to a university lectureship, and in 1928 he was proctor. In 1929 he explored the Hippodrome at Constantinople for the British Academy. In later years he gave much time to organized visits of younger students to Greece, and to more general and popular writings, "The Progress of Archæology" (1935), "The Discovery of Mars" (1939) and "Progress and Catastrophe" (1937), the last a remarkable anticipation of present disasters. He wrote also reminiscences of war service, a detective story, a volume of essays on "Ancient Cyprus" (1937), and in 1939–43 valuable summaries of the history and services of the Greeks, "Greece and Britain", "Greece and the Axis" and a re-issue of his "Ancient Greece". He was a fellow of the Society of Antiquaries, honorary associate of the Royal Institute of British Architects, member of the German Archæological Institute and honorary member of the Bulgarian Archæological Institute. In 1939 he rejoined the Intelligence Corps, served in the Netherlands and in Greece, and was again on active service when he was killed in April 1944. He leaves a wife and one daughter.

Casson was a devoted and effective exponent of Greek antiquity, in all aspects and periods, especially of the sculpture and its counterparts in modern Europe. He had also exceptionally wide knowledge of the modern Greek people, among whom he was widely known and very popular. JOHN L. MYRES.

Mr. L. V. Lester-Garland

LESTER VALLIS LESTER-GARLAND (*olim* Lester), who died on March 23, was of the scholarly type of botanist more common in former days. Born on July 28, 1860, he was educated at Sherborne School and at Magdalen College, Oxford, where he held a demyship. He took a first in classical moderations and in 'Greats'. After being an assistant master at St. Edward's School, Oxford, during 1883–86, he became fellow and lecturer at St. John's College, Oxford, where he remained for ten years. In 1896 he became president of Victoria College, Jersey, retiring in 1911.

Lester-Garland is best known botanically for his "Flora of the Island of Jersey", published in 1903. This small volume is a model of what a local Flora should be. Incidentally, it was the first British Flora to adopt the Engler system of classification. In the introduction he asserts that if British botanists "are ever to emancipate themselves from the insular ideas which too often dominate the science, they will have to learn to look abroad, and realize that British plants grow in other places besides Great Britain and Ireland, and that the British flora is only an insignificant portion of the flora of the globe". The need was probably brought home to him by the continental affinities of the Jersey flora, with its conspicuous Mediterranean element; it led him to criticize the continued use of Watson's 'types' as tending to limit the views of British botanists on plant distribution.

His only other botanical publications were short papers, but for some time after leaving Jersey he was prominent in London botanical circles, and served on the council of the Linnean Society during 1923–26. On moving to Bathford he busied himself with local affairs and restricted his writings to religious philosophy.

Lester-Garland had a charming and unassuming manner which covered not only a wise, scholarly knowledge but also a sense of humour and convictions which were strongly, but not stupidly, held.

J. RAMSBOTTOM.

Dr. A. R. Jackson

WITH the death of Dr. A. Randall Jackson at his home in Chester on March 18 we lose our leading British systematic arachnologist. Despite a busy medical practice, he always found time to provide unstinted help to numerous correspondents in the identification of their collections of British and Arctic spiders, phalangids and chelonethids. This flair for diagnosis has never been surpassed. It enabled him both to straighten out the synonymic muddles created by other workers and also to add many species to the British list. Despite the constant pleadings of his friends, he published comparatively few papers and, as these were often in obscure journals, the excellence of his work never gained the wide recognition it deserved.

A rugged exterior concealed a sensitive and sentimental nature with a deep interest in the beauty of good literature, paintings and garden flowers. A manner, at times somewhat cynical, was apt to hide a keen sense of humour, conscientious attention to his medical practice and, above all, the kindness and generosity he always showed to young collectors. His death is a serious loss to British arachnology.

W. S. BRISTOWE.

NEWS and VIEWS

Mr. G. Shaw Scott and the Institute of Metals

THE first decade of the twentieth century produced a number of explorers keen to discover in the science of metals the most efficient and economic ways to adapt 'brass and iron' to the service of man. Papers published at the time were concerned with the microstructures of metals and alloys, and the influence of the nature and distribution of micro-constituents on mechanical properties. Hence there arose a need for the results of such work to be published among manufacturers and users of metal, while scientific men required a fellowship for mutual help and criticism. The Institute of Metals was founded to meet these needs in September 1908, its temporary headquarters being the Department of Metallurgy of the University of Birmingham. The first secretary was Mr. Gilbert Shaw Scott, who is now retiring after thirty-two years of service.

In 1906, Mr. Shaw Scott graduated at the University of Birmingham as its first graduate in metallurgy, and was the first research student in the Department. In 1908 he read a paper on case hardening to the Iron and Steel Institute at its meeting in Vienna. From a large number of candidates, he was chosen to be the first secretary of the new Institute, and under his guidance it has grown from its original membership of 250 to a present world-wide membership of 2,500. Examples of scientific and technical progress with which he has been associated as secretary and editor to the Institute of Metals include the new knowledge of metallic crystals, equilibrium diagrams and micro-constituents of metals and alloys, the industrial use of microscope and pyrometer as instruments for the control of quantity and quality; the discovery and development of modern alloys of aluminium; the discovery of a copper alloy which can be hardened and tempered by heat treatment; the winning battle against corrosion, and bright annealing. Since 1908, his services to the members of the Institute of Metals have been to make available the new knowledge so necessary to the metallurgical industries. His friends will remember gratefully the prompt help and genial advice always received, and wish him on retirement many happy days.

Charles L. Mayer Prize of the U.S. National Science Fund: Dr. Alexander Lipschütz

DR. ALEXANDER LIPSCHÜTZ, director of the Department of Experimental Medicine of the Chilean National Health Service at Santiago, Chile, has been awarded the second 2,000 dollars prize given by Dr. Charles L. Mayer and administered by the National Science Fund of the U.S. National Academy of Sciences. The award was offered for an outstanding contribution made in 1943 to present-day knowledge of factors affecting the growth of animal cells with particular reference to human cancer. Dr. Lipschütz was born in Riga, where he received his early education. He occupied various positions in medicine and physiology at institutions in Switzerland and Germany before going to Chile about fifteen years ago to work at the Catholic University at Concepcion. Since 1938 he has been director of the Department of Experimental Medicine of the National Health Service at Santiago, Chile. Throughout the past six years Dr. Lipschütz, with Chilean collaborators, has studied the fibromyomas of the uterus which can be induced in guinea pigs by the injection of certain sex hormones of the female. The growths closely resemble the fibromyomas ('fibroids') which occur in women during the childbearing period, and Dr. Lipschütz has shown that, like these, they dwindle and vanish when the stimulation of the sex hormones is withdrawn, as happens after the menopause in women. He and his associates have sought means to prevent the occurrence and enlargement of the growths while the hormones are still acting, and recently they have found that some other hormones have this effect, as do also certain synthetic substances. The molecular configurations responsible for the influence of the antifibromatogenic agents are now under investigation; a progress report by Dr. Lipschütz was published in NATURE of February 26, 1944, p. 260.

Award for Production of Magnesium and Calcium

MR. G. D. BAGLEY, leader of the experimental engineering group of the Union Carbide and Carbon Research Division, has been awarded the Jacob F. Schoellkopf Medal for 1944 by the Western New York Section of the American Chemical Society, for "outstanding and highly significant work, particularly in the fields of the commercialization of very active metals". Largely through his chemical and engineering skill, a process has been developed which produces magnesium in high-temperature vacuum furnaces with capacities which were formerly thought to be impossible. Previously, the dolomite-ferrosilicon reaction for making metallic magnesium had always been considered a laboratory curiosity. Mr. Bagley's production methods are being carried out at the Electro Metallurgical Company's plant at Spokane, Washington, with a rated capacity of 24,000 tons a year. Mr. Bagley has also developed a method for the production of metallic calcium. Before the War, calcium came almost exclusively from France and was made in small cells at a high production cost. When this source was cut off, Mr. Bagley designed large automatic cells, which are now producing a purer product at a considerably reduced cost. Mr. Bagley, who has been with the Union Carbide and Carbon Research Laboratories since 1918, has also been wholly or partially responsible for many other highly important chemical and chemical engineering developments.

Federation of British Industries: Industrial Research Committee

THE Federation of British Industries has decided to strengthen its organization on the research side by making its Industrial Research Committee a permanent standing committee of the Federation, with its own secretariat. By its terms of reference this Committee will seek to stimulate national interest in research for industry and foster it in all appropriate ways. Thus it will encourage industrialists to devote a more adequate part of their resources to the promotion of research and its application to existing products and to the development of new products. It will provide money for the creation and maintenance of adequate facilities for postgraduate research; and encourage the education of the necessary research and development staff of universities, technical colleges and industrial establishments. The

Committee will promote contact and collaboration wherever possible between centres of industrial research or institutions and research workers; and facilitate co-operative research within British industry, with special reference to the needs of small-scale industries. Information on research questions will be provided by creating a liaison with appropriate reference libraries and technical and scientific institutions; and attention directed to the publications of professional, technical and scientific institutions, assistance being given where necessary in their distribution. The Committee will promote the compilation of general information on industrial research, particulars of organizations and the facilities available; and provide from time to time information for press and public on the achievements of British industrial research.

A Medical Nobel Institute in Sweden

The Royal Caroline Institute (Kungl. Karolinska Medico-Kirurgiska Institutet), which is the medical school of Stockholm—the University of Stockholm (Stockholms Högskola) having no medical faculty—and is in charge of the medical Nobel Fund, has decided to build a Medical Nobel Institute for research in the three theoretical disciplines, anatomy, biochemistry and physiology. The new Institute will consist of three departments in one building to be erected on the premises of the new medical centre at Norrbacka in the north-west region of the city. The Biochemical Nobel Institute was founded in 1937 and is directed by Prof. Hugo Theorell. The physiological department will be a Neurophysiological Research Laboratory privately endowed in 1940 for Prof. Ragnar Granit, who will also be in charge of the new institute. The anatomical department will be associated with a new chair in cell research to be created for Dr. Torbjörn Caspersson.

Relation of Employment to an Economic System

A memorandum "Employment After the War" submitted by the Social Credit Co-ordinating Committee, Greno House, Swinton, Mexborough, Yorks (3*d.*), for the consideration of Sir William Beveridge, argues that full employment is not the right objective of an efficient economic system. The essential function of industry is to supply the goods and services which people require, and it is no part of the function of industry to deprive people of leisure or to keep them occupied in order to reduce the difficulties of Government. Social security, with freedom, can only be realized if we recognize, first, that production is no longer a major problem: the problem to-day is that of distributing the abundance of goods that can be produced. Further, money is the social mechanism for the distribution of goods: thirdly, science has so well succeeded in harnessing solar energy to the service of man that the need for human labour in industry has decreased and will continue to decrease progressively; and, lastly, the true purpose of employment is to provide goods and services for our use and not to provide people with incomes. The memorandum then briefly summarizes the Social Credit proposals: a national credit office; the institution of a scientific price discount; and the distribution of national dividends. These proposals are designed to deal with what is described as the real problem, which is not how to share out the hours of work available, but how to remove from unemployment its ugly concomitants of frustration and a low standard of living.

Institute of Medical Laboratory Technology

The Institute of Medical Laboratory Technology, which was incorporated in November 1942, with registered offices at 308 Dewsbury Road, Wakefield, Yorks, has issued a memorandum and articles of association. All scientific workers will commend the objects of this Institute. As its secretary, Mr. S. J. Denyer, says, its formation "indicates the desire of the laboratory technician to meet the increased demands of his profession and to acquire the professional status already accorded to other scientific workers". The Institute incorporates the Pathological and Bacteriological Laboratory Assistants Association and takes over the publication of the *Laboratory Journal* and the *Monthly Bulletin* previously issued by that Association. To meet modern demands, the Institute requires an approved educational standard as one qualification for membership. Ordinary members or associates of the Pathological and Bacteriological Laboratory Assistants Association may become ordinary members of the Institute by application, but others must be elected; they must be not less than twenty years old, they must have had not less than three years experience in an approved pathological, bacteriological or chemical pathology laboratory and must pass an intermediate examination controlled by the Institute. Candidates for the associateship of the Institute must either hold the certificate of the parent Association in one subject or must, after completing five years training in an approved laboratory and attaining the age of twenty-two, pass the Institute's final examination in one subject. Fellows must have been registered members of the parent Association for ten or more years, or must hold that Association's certificates in two or more subjects; in either case they can become fellows by application. Others may be elected to fellowship if they are already associates of the Institute and either pass the Institute's final examination in two or more subjects or submit an acceptable thesis, and have also been associates of the Institute for ten or more years, inclusive of previous registered membership of the parent Association.

It will be clear that the associateship and the fellowship of the new Institute are not lightly acquired, and ordinary membership must itself command respect. This will give to the technicians in the laboratories concerned the status which they deserve, for without their willing help, their interest in the work and their devotion to it, many great discoveries would not have been made. It is good to know that members of the medical profession give willingly of their time to help to train these essential workers; every other kind of scientific worker will wish to do the same.

Smithsonian Institution: Annual Report

The report of the Smithsonian Institution for the year ended June 30, 1942 (Washington, D.C.: Gov. Printing Office. 1.50 dollars), includes the report of the secretary together with the reports on the United States National Museum, the Bureau of American Ethnology, the International Exchange Service, the National Zoological Park, the Astrophysical Observatory, and the Division of Radiation and Organisms, together with a general appendix on the lines of that in the previous report. Referring to the war activities of the Institution, the secretary's report states that a War Committee has been constituted and a detailed roster prepared of the scientific staff, numbering

nearly a hundred, listing their geographical and specialized knowledge. From war agencies 460 requests for information have been received since the Pearl Harbour disaster, and the Institution is also serving as an important source of technical and geographical information. Together with the National Research Council, the American Council of Learned Societies, and the Social Science Research Council, the Institution has participated in the setting up of the Ethnogeographic Board to provide a central clearing house for information to army and navy intelligence and other war agencies in geography, languages and social sciences. An index of published photographs taken by scientific workers of the Institution in all parts of the world is being compiled.

The Institution has also undertaken the publication of a handbook of the Indians of South America, under the editorship of Dr. J. H. Seward, of the Bureau of American Ethnology, as well as of a list of the insects of South and Central America. Volume 6 of the *Annals of the Astrophysical Observatory*, covering its operations from 1920 to 1939, was published during the year and describes in detail the research on the variation of the sun's radiation. The Division of Radiation and Organisms, which was incorporated during the year as a branch of the Observatory, has continued its work on photosynthesis, plant growth and radiation, and the development of apparatus and methods. Experiments were continued on the factors that influence the changes in rates of respiration of plants, and work is in progress on the isolation and separation of two pigments that occur in dark-grown oat seedlings. The general appendix includes in the first place a statement "The 1914 Tests of the Langley 'Aerodrome' ", by C. G. Abbot, which terminates the controversy between Dr. Orville Wright and the Institution. Among the original and unpublished papers in this appendix are those by J. A. Fleming on "The Sun and the Earth's Magnetic Field", E. P. Henderson and S. N. Perry on "Meteorites and their Metallic Constituents", and C. M. Packard on "Insect Enemies of our Cereal Crops".

Copper Conductors for Overhead Lines

IN a paper read by Messrs. G. W. Preston and H. G. Taylor in London on April 12 before the Institution of Electrical Engineers, the creep of copper conductors and their initial non-elastic extension are considered in relation to their effect on sags and their compensation by an increase in erection tension as an alternative to pre-stressing. Information is given on the annealing characteristics of hard-drawn copper and copper-alloy conductors, with special reference to the effect of impurities in the metal, and maximum safe operating temperatures for such conductors are discussed, together with maximum permissible current loadings. Hollow copper conductors of various types for super-voltage lines are described, and the features of cadmium-copper conductors are dealt with in comparison with other types of high-tensile overhead conductor. Steel-reinforced copper conductors receive special attention, particularly in regard to the protection from corrosion of the steel wires, and results of a long-time investigation are given in full, with conclusions and recommendations. Copper-clad steel wires, their characteristics and use as reinforcement in copper conductors are discussed. Details are given of developments in the application of compressed sleeve joints to copper and copper-alloy conductors, and suitable joints for cadmium-copper and steel-cored copper conductors are described and test results given.

New Products from Cellulose

ACCORDING to an annotation in the January issue of the *Anglo-Swedish Review*, the Swedish Cellulose Co. recently put on the market a wood-pulp product named 'Cellufix'; its manufacture requires the use of alkali, chlorine and alcohol, all of which are produced in Sweden. It is viscous, soluble in water at any temperature and so highly concentrated that a 3 per cent solution will yield a consistency equal to butter. It is odourless and tasteless, and its present main use is as wall-paper paste, as putty and for part of white-wash. 'Cellufix' is also used in textile mills as size and for other purposes. A specially purified quality of 'Cellufix' called 'Cellugel' is used in the food and chemical industries to give bulk to certain products and is also used as a substitute for glycerine.

Planetaria of the World

MR. ROY K. MARSHALL continues his articles on this subject in the December and January issues of *Sky and Telescope* (see NATURE, **153**, 191; Feb. 12, 1944) with a very full description of the Fels Planetarium at the Franklin Institute, Philadelphia. He includes a few photographs of other planetaria also. The technical details of the instrument will prove interesting to many readers. The most complicated feature of the planetarium is the mechanism which reproduces the motions of the sun, moon and planets, and it is remarkable that comparatively few visitors make any inquiries about this. Five projectors are in the sun cage, and two of these are for a glow of light or aureole around the sun's image, simulating the strong scattering of light seen in the neighbourhood of the sun. One is for the zodiacal light, and a pair for the glow of the gegenschein. The precession of the equinoxes is reproduced in the planetarium by rotating the dumbbell portion of the instrument about an axis, and in 75 seconds it is possible to pass through the whole cycle of nearly 26,000 years. On certain occasions demonstrations of a highly dramatic nature have been presented—including a trip to the moon during which very realistic reproductions of lunar craters are produced. In the words of Dr. Philip Fox, describing the first Adler Planetarium, it is "not a trivial plaything, a mimic aping firmament, but the heavens portrayed in great dignity and splendour, dynamic, inspiring, in a way that dispels the mystery but retains the majesty".

Rainfall in the Nile Basin

A SYNOPSIS of rainfall statistics for the Nile Basin up to 1937 forms a valuable volume ("The Nile Basin", 6. By H. E. Hurst and R. P. Black. Physical Dept. Paper No. 43. Ministry of Public Works, Egypt. Cairo, 1943. 10*s*.). It includes figures from the Sudan, Uganda, Kenya, Tanganyika and the Belgian Congo. There are also figures, though admittedly incomplete, from Abyssinia. The stations are grouped by countries, and within each group are arranged by latitude from north to south. Statistics just outside the limits of the Nile basin are included. As a rule, stations with less than five years records are omitted. Figures from about four hundred stations make it possible to give a large-scale map of the total annual rainfall

of the basin, and there are also graphs of the normal monthly rainfall and number of rainy days for selected stations in addition to the lists of these facts for each station where available. The volume concludes with a bibliography and a detailed index to stations.

Public Health in Costa Rica

THE March issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an article on this subject by the President, Dr. Rafael A. Calderón Guardia. The following details are of interest. The birth-rate for 1941 was 42·9 (slight increase) and the death-rate 17 per 1,000. The death-rate for children under one year fell from 132·4 per 1,000 in 1940 to 123·5 in 1941. The services for pre-school and school children have been extended, 11,074 children having been attended by medical men and 18,130 by dentists. During 1941 a section was formed to provide shoes for school children, one of the most important measures for protection of their health. For the first time a travelling exhibition for health education was started and circulated throughout the country. The Tuberculosis Division continued its work of systematic examination of the employees of the various divisions of the department of public health. Of 24,322 persons examined for venereal diseases, 4,242 were found to be infected and 1,305 were classified as doubtful. Soil sanitation was carried out intensively. The anti-malarial campaign was carried on according to the plans of the Rockefeller Foundation. New buildings have been constructed for health units in different parts of the country.

Undulant Fever in Chile

IN a recent article (*Bol. Of. San. Panamericana*, 22, 400 ; 1943) Enrique Onetto, director of the Diagnostic Laboratory of the Chile Bacteriological Institute, discusses the historical aspects and present state of undulant fever in Chile. The disease was first diagnosed in that country in 1931, when it was found near Santiago, and in 1940 a new focus was discovered in the northern part of the country. The commonest variety is *Brucella melitensis*, though *Br. abortus* has also been isolated in cattle. The infection is most prevalent in the southern part of Chile. Since 1936 the Huddleson reaction has been performed systematically on all the sera received for the Widal reaction. In 1936 also the Department of Public Health created a permanent commission for the study of brucellosis composed of medical men, bacteriologists and veterinarians.

Rudolf Boehm (1844–1926)

PROF. RUDOLF BOEHM, a prominent pharmacologist, was born on May 19, 1844, at Nördlingen in Bavaria, the son of a medical man. He received his medical education at Munich, Würzburg and Leipzig, where he qualified in 1867. He first devoted himself to psychiatry, serving as assistant in the psychiatric clinic at Würzburg. Afterwards he took up the study of pharmacology at Leipzig and commenced his important studies on cardiac poisons. In 1871 he was appointed assistant at the Physiological Institute at Würzburg under A. Fick, and in the following year succeeded Schmiedeberg in the chair of pharmacology at Dorpat, eventually holding the corresponding chairs at Marburg and Leipzig. He died on August 16, 1926, in Upper Bavaria. Besides numerous pharmacological articles on veratrin, aconitin, arsenic, digitalis, and curare, and physiological investigations, especially on carbohydrate metabolism, he was the author of a "Lehrbuch der allgemeinen und speziellen Arzneiverordnungslehre" in 1884, the third edition appearing in 1903.

Announcements

SIR LEWIS FERMOR, formerly director of the Geological Survey of India, has been awarded the P. N. Bose Memorial Medal for 1943 of the Royal Asiatic Society of Bengal, in recognition of his "conspicuously important researches on the Archæan Rocks of India".

PROF. C. M. YONGE, professor of zoology in the University of Bristol, has been appointed regius professor in the University of Glasgow, in succession to Prof. E. Hindle, who has become scientific director of the Zoological Society of London.

THE Rockefeller Foundation has made a grant of 15,000 rupees (about £1,100) to the National Institute of Sciences of India, to give assistance in the publication of scientific papers in Indian journals. This grant is similar in character to that which has been made by the Foundation to the Royal Society annually for some years, for assisting the publication of scientific papers in Great Britain.

THE following appointments in the Colonial Service have recently been made: O. J. Voelcker (senior botanist, Nigeria), seconded to Gold Coast for duty in connexion with cocoa diseases; D. Stevenson (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; J. A. Wills (senior assistant conservator of forests, Gold Coast), conservator of forests, Gold Coast; C. M. Tattam (senior geologist, Nigeria), deputy director of geological surveys, Nigeria.

BY arrangement with the University of Cambridge, the Medical Research Council has established a Unit for Research in Applied Psychology at Cambridge. The Unit is located in the University Psychological Laboratory, the head of which is Prof. F. C. Bartlett. Dr. K. J. W. Craik has been appointed to the Council's staff as director of the Unit, and will have the collaboration or assistance of other workers there in the Council's service. The members of the Unit will undertake work elsewhere than at Cambridge when required, including investigations within the field of the Council's Industrial Health Research Board.

THE Institution of Chemical Engineers and the Institute of Physics announce a joint conference on "Instruments for the Automatic Controlling and Recording of Chemical and Other Processes". Provisional arrangements have been made for the conference to take place in London on September 22 and 23. The purpose of the conference is to promote the interchange of knowledge and experience between those employing automatic controllers and recorders in different fields and to encourage collaboration between physicists and chemical engineers. The conference will be open to all interested without charge. Further particulars will be sent, in August, to those sending a request for them to the Organizing Secretary, Joint Conference, c/o The Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Physico-Chemical Properties of the Surface of Growing Plant Cells

FROM measurements of the surface potential of growing roots of wheat seedlings, it was concluded that the protoplasmic membrane behaves as an amphoteric colloid with pronounced acid dissociation[1]. The protoplasmic membrane probably contains small amounts of a comparatively strong high-molecular acid (pK = c. 1) and still smaller amounts of a comparatively weak base. The main substance of the membrane is apparently not dissociated. The hypothetical acid (R^-) reacts with neutral salts according to the equation $H^+R^- + M^+A^- = M^+R^- + H^+A^-$, following the law of mass action[2]. The acid constituent of the protoplasmic membrane was supposed to be a phosphoric acid in organic linkage.

Earlier spectrochemical investigations of nutrient solutions, in which roots had grown for some time[3], revealed the presence of organic compounds with high absorption in the ultra-violet. These compounds, which are apparently exuded from living cells, contained phosphoric acid and were provisionally identified with phosphatides. Later potential measurements showed, on the other hand, that the presence of phosphatides in the protoplasmic membrane of the growing cells of roots is less probable. A renewed spectrographical and chemical investigation of the root exudates was therefore attempted.

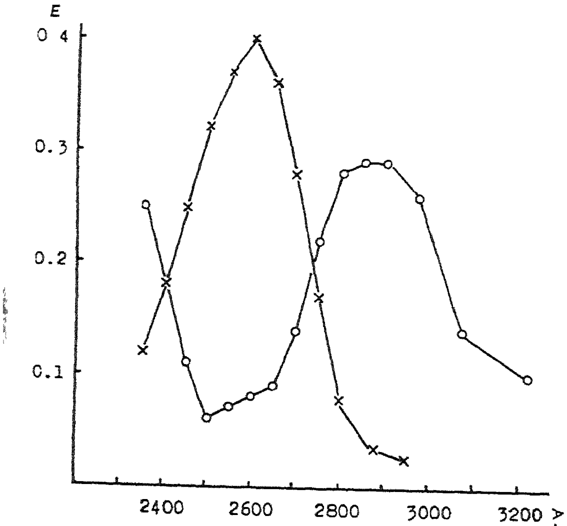

FIG. 1.

The exuded substances are always of the same kind, irrespective of the pH of the solution. Generally, however, the concentration of the exudate increases with the acidity of the medium in which the living wheat roots are submersed. The best medium is distilled water, in which exudates of comparatively high concentration are obtained. The fresh solution of the exudate gives a spectrum with a high absorption maximum extinction at c. 2600 A. and a lower maximum at c. 2850 A. (Fig. 1). The former coincides

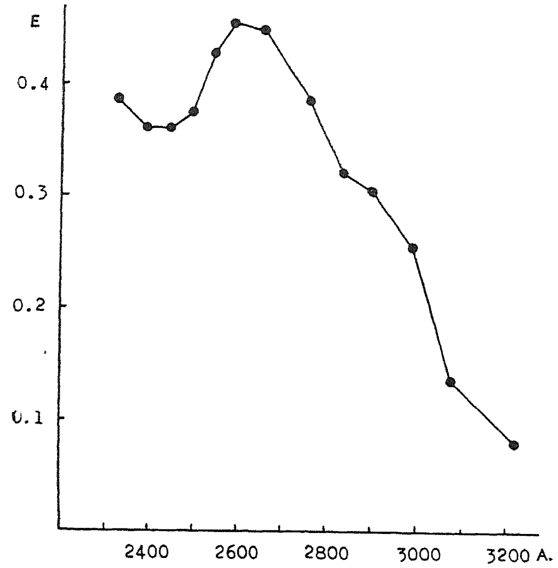

FIG. 2.

with the absorption maximum of purine bases, characteristic of nucleotides. From the known molar extinction of adenylic acid, the probable amount of nucleotide was calculated. A microchemical determination of pentoses in the exudate gave similar values. Furthermore, the amount of PO_4 in organic linkage corresponds to 1–3 moles per mole nucleotide. The substance causing the strong absorption at 2600 A. is therefore probably adenosine phosphoric acid (1–3 PO_4).

On subtracting the spectrum of the supposed adenosine phosphoric acid from the 'raw' spectrum in Fig. 1 we obtain a spectrum with a high peak at c. 2550 A. (Fig. 2). The exudate developed a faint yellow colour in the presence of alkali. After the addition of basic lead acetate a distinct yellow colour appeared, which turned wine-red after the addition of sulphuric acid in excess. These colour reactions are characteristic of dyes belonging to the flavone group. The absorption band at 2550 A. corresponds to the spectrum of flavanone[4]. This substance also gives no absorption between 3200 and 4000 A. The absorption of the lead compound of the dye in the visible part of the spectrum (c. 4700 A.) corresponds to the absorption in the ultra-violet; the second substance in the exudate is therefore probably a flavanone. According to earlier biochemical investigations[5], only flavones with two hydroxyl groups in ortho-positions on the phenyl group are able to participate as oxidizing links in a system consisting of peroxidase and ascorbic acid. On testing our exudate with a mixture of ascorbic acid, hydrogen peroxide and peroxidase, we actually obtained an obvious acceleration of the decomposition of the ascorbic acid. The substance in the exudate causing the absorption band at 2850 A. is thus probably a 3′,4′-dioxyflavanone. Proteins which have an absorption band at a similar wavelength are not present in the exudate.

The fact that nucleotides are exuded from living roots supports the conclusion that these substances are constituents of the protoplasmic membrane of epidermis cells. Root tips (5 mm.) exude per unit dry weight 2–4 times as much nucleotide as the rest of the root. The zone of fastest elongation of the cells (about 2 mm. from the vegetative point) shows

the highest electro-negative potential[6] and the carriers of the potential are perhaps nucleotide molecules, which are scattered in a non-dissociated ground substance of the membrane and from time to time are thrown off from it. New molecules are probably continuously added from the interior of the growing cell, which always contains much nucleic acid[7]. The adenosine phosphoric acid in the protoplasmic membrane of growing cells is perhaps part of a system building up the cellulose wall.

If nucleotides serve as formative bricks in the protoplasmic membrane of growing cells, the permeability of these cells ought to be rather different from that of fully grown cells, which are supposed to be coated with a neutral membrane of more or less lipoid character. Unpublished observations in this laboratory show that growing root hairs admit substances through the protoplasm which are held back by fully grown cells. The exudate in distilled water always contains large amounts (60–70 per cent or more) of glucose. The protoplasmic membrane of growing cells obviously has larger pores than that of fully grown cells. The molecules of the flavanone (molecular weight *c.* 288) possibly permeate from the interior of the cells, but they perhaps also form part of an oxidation system in the protoplasm, for example, in linkage to the adenosine phosphate or as glucosides. The fact that acid reaction of the medium increases the exudation makes it probable that nucleotides are split off from the protoplasmic membrane by hydrolysis. The production of nucleic acids decreases or ceases completely after the end of the nuclear division and, if the hydrolysis continues during the ageing of the cells, the protoplasmic membrane will finally be free from nucleotides and acquire the well-known restrictive permeability of fully grown cells.

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Growth-Factors Required for the Nutrition of *Lactobacillus casei* ε

AFTER allowing for the effect of all the then known vitamins of the B complex, investigations by Macrae *et al.*[1] established the presence of another rat growth-factor (factor β) in the amyl alcohol insoluble fraction of acidified liver concentrates. It was shown in Leeds that this factor was essential for the growth of *C. diphtheriæ* (types *intermedius* and *gravis*), and further work on the factor demonstrated its necessity for the growth of *L. casei* (cf. Chattaway *et al.*[2]) and its non-identity with aneurin, riboflavin, pyridoxine hydrochloride, nicotinic acid, choline hydrochloride, calcium pantothenate, inositol and biotin.

Later experiments indicated that the growth-factor requirements of *C. diphtheriæ* differed from those of *L. casei*, the latter appearing the more complex, thus suggesting that these amyl alcohol insoluble concentrates contained more than one active component. The factor required for the nutrition of *C. diphtheriæ* has been described more fully in a paper by Chattaway, Happold and Sandford[3]. The following is a brief summary of the work so far done in these laboratories on the factors necessary for the aerobic growth of *L. casei* ε.

Three factors have so far been indicated: Factor 1, the growth-factor required also by *C. diphtheriæ*; Factor 2, a factor appearing to be concerned in the amount of growth of *L. casei*; Factor 3, which seems to be necessary mainly for the production of acid.

Factor 1 occurs in casein hydrolysate, and, using a casein digest medium, *C. diphtheriæ* can be grown without the addition of liver concentrates or any external additions of unknown growth-factors. It has been shown that using an amino-acid medium, this factor is necessary for the growth of *L. casei* in the presence of Factors 2 and 3. Active liver fractions, adsorbed on fuller's earth, have been found inactive for its nutrition until Factor 1 was added, and the activity of fractions extracted by aqueous butyl alcohol is also very much improved by the addition of this factor. Among its distinguishing chemical properties are the following: it is not precipitated by saturation with ammonium sulphate; not extracted from aqueous solution by butyl and amyl alcohols; not extractable by phenol and *p*-cresol; gives no insoluble derivatives with lead, silver, or phosphotungstic acid; gives no insoluble picrate; is not adsorbed on fuller's earth at *p*H 3; is adsorbed on norite at *p*H 3 and eluted by alcohol ammonia.

Factor 2 appears to be responsible for the speed of the initial growth of *L. casei*. Many observations have led to the conclusion that acid production is not directly proportional to the weight of micro-organism obtained. This factor increases largely the amount of visible growth, especially during the first twenty-four hours of incubation. Pollack and Lindner[4] indicate a similar factor in Wilson's bacteriological peptone, and the same result is given by extracts of crude nucleic acid, commercial trypsin, etc.: the properties so far detected include: some precipitation with ammonium sulphate from crude extracts (no appreciable inactivation with proteolytic enzymes); solubility in aqueous butyl alcohol; partial solubility in aqueous amyl alcohol, especially with reasonably purified fractions; adsorption on norite at *p*H 3; very little adsorption on fuller's earth at acid *p*H.

Factor 3. This apparently occurs as a free growth-factor and also in a combined form. It is this factor which seems to be principally responsible for the acid production of *L. casei* ε in our medium. It probably occurs in liver largely in the combined form. This appears to be inactive, but on mild hydrolysis yields the free growth-factor. Factor 3 is more readily separated than the other two. It is not precipitated by ammonium sulphate; soluble in aqueous butyl alcohol; insoluble in aqueous amyl alcohol; gives salts with lead and silver; precipitated by phosphotungstic acid; soluble in phenol and *p*-cresol; adsorbed on norite at *p*H 3; adsorbed with difficulty on fuller's earth at *p*H 3.

All extracts of this factor are persistently and noticeably acid. As an example, it may be quoted that the activity extracted from a neutral solution by butyl alcohol is invariably acid in reaction. This phenomenon is so general that it appears probable that this acidity is a characteristic of the growth-factor itself. There is also some evidence that this factor forms a picrate at *p*H 4.

The combined form of Factor 3 has very different

properties. It is soluble in 50 per cent aqueous alcohol, insoluble in 98 per cent alcohol, insoluble in aqueous butyl and amyl alcohols, not adsorbed by fuller's earth, adsorbed by norite, not soluble in phenol, *p*-cresol, etc.; on hydrolysis with dilute mineral acids or by pepsin, further quantities of Factor 3 can be produced.

A clear-cut and absolute division into an active and inactive fraction has never been obtained; 70–80 per cent of the activity is the most that any one process will yield, so that on purification there is always a loss of material, and the complete separation of the three factors is a matter of some difficulty.

Prof. R. J. Williams has very kindly supplied us with samples of his folic acid, and comparative tests have been carried out with this fraction. The results obtained have not been very satisfactory; and even with the addition of Factor 1, only small amounts of growth and acid production have been found to occur with the media used in these laboratories[5].

We hope to publish shortly a fuller account of this work discussing the methods and media employed; and shall then endeavour to show, so far as possible, the connexion between these factors and the many similar factors obtained by other workers interested in the same field of research.

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A New Genus of Terrestrial Algæ

IN the damper hothouses of the Cambridge Botanical Gardens, there occurs in some quantity a green alga growing on fragments of oolitic limestone. It constitutes a new genus (Cladophorella) of Cladophoraceæ, and its discovery is of interest from several points of view. Pieces of the same kind of oolitic rock are present in some of the cooler houses, as well as in parts of the rock garden; moreover, a very similar material has been used in the construction of many of the Cambridge colleges. A search has failed to reveal Cladophorella elsewhere than in the hothouses, so that on present evidence it would appear to be an introduced tropical form. The Cladophorales were the only major group of Green Algæ in which so far no truly terrestrial representatives had been found, and the discovery of Cladophorella shows that the capacity for a subaerial existence is general among the groups of Chlorophyceæ.

The alga consists of a complex system of horizontal threads, readily breaking away from one another at the septa and attached to the rock by elongate, for the most part unicellular, rhizoids. From the horizontal threads arise erect-growing branching filaments reaching a height of 3–5 mm. and forming dense tufts. Growth of the threads is apical. The cell-structure is that of a Cladophora, the vegetative cells possessing a parietal reticulate chloroplast with numerous pyrenoids and a limited number of nuclei internal to the chloroplast. As the erect threads elongate, the bulk of the cell-contents concentrates in the cells at the tips of their branches. These cells develop into akinetes with a thick lamellate membrane and a dense chloroplast harbouring numerous large pyrenoids; there is probably also some multiplication of nuclei. Apart from fragmentation of the threads *in situ*, the akinetes seem to constitute the only means of reproduction. They are readily detached and are no doubt wind-dispersed.

A feature of particular interest lies in the special properties of the surface-layer of the membrane, covering the akinetes and other of the upper cells. This layer, which forms a continuous covering, approximates in many respects to a true cuticle, such as has, so far as I am aware, not yet been demonstrated in an alga. It resists 60 hours immersion in concentrated sulphuric acid and prolonged treatment with a 50 per cent solution of chromic acid. The persisting cuticle, after removal of the acid, stains distinctly with Sudan III or Sharlach *R*, although the stain is in general not very deep. Treatment of fresh material with either of these reagents affords some evidence of staining of the surface layer of the membrane in all parts of the plant, and it seems likely that it may exhibit some cuticularization throughout, though this is only pronounced on the upper parts of the erect threads. Mature akinetes exhibit practically no contraction when allowed to dry in the air of the laboratory and, while other factors may come into play as well, this is no doubt largely due to the properties of the enveloping cuticle.

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Carbon Dioxide Content of Atmospheric Air

As a sideline to an investigation on the water vapour content of the upper air, the carbon dioxide content has been determined in a number of air samples obtained by balloon soundings from heights of 4–10 km.

The samples were analysed by freezing out the carbon dioxide and water with liquid air and, after pumping off all the other gases, the pressure of the combined water vapour and carbon dioxide was measured in a McLeod gauge both at 100° C. (p_{100}) and at 0° C. (p_0). By deducting the saturation pressure of water (4·56 mm. mercury) from the latter value, the carbon dioxide pressure was obtained. As the quantity of condensed water was only a few micrograms, the solubility of carbon dioxide in the condensate was completely negligible.

The method of collecting the air samples was developed in collaboration with Mr. L. H. G. Dines, of Kew Observatory, and was similar to that used in obtaining air samples for the determination of the helium content in the stratosphere[1]. The vessel was opened—as described by Dines[2]—by breaking a capillary attached to the sampling vessel, and it was closed by fusing the same capillary by means of an electrically-heated spiral of platinum wire. Even with such a clean method, the danger of contamination by carbon dioxide from the burning of traces of

organic matter on or near the heated parts proved extremely great. The first results gave figures for the carbon dioxide content of the free air which were just as erratic and high as those found by Lepape and Colange[3] in their analyses of upper air samples (0·03–0·13 per cent) from heights of 9–16 km.

In the end, however, a satisfactory technique was evolved, so that, even without air ventilation, samples of air free from carbon dioxide taken under identical conditions in the laboratory gave a contamination of less than 0·001 per cent carbon dioxide. With this improved method and a maximum of air ventilation at the moment of sampling, the following carbon dioxide contents (volume per cent) were obtained from a sequence of twelve air samples taken at 4–10 km. height over England.

0 025	0 025
0 024	0 030
0·028	0·025
0·024	0 024
0·024	0 024
0·025	0 026

With the exception of two samples, which may well have suffered from accidental contamination, these figures show a remarkable constancy.

Analyses of air samples taken on the ground at Kew Observatory, and analysed by the same method, gave values of 0·031–0·035 per cent. Air from the tower of Imperial College, London, gave 0·035–0·037 per cent, while inside the laboratory, according to the state of ventilation, values between 0·041 and 0·107 per cent were found. Analyses by J. S. Haldane and R. H. Makgill[4] showed large variations of the carbon dioxide content (0·021–0·044) even in country air at levels more than 4 ft. from the ground, and still greater amounts on and below the ground. T. M. Carpenter[5], on the other hand, finds in a series of 790 analyses at Baltimore, U.S.A., that variations are limited to a range of 0·028–0·033 per cent.

Thus, while the carbon dioxide content near the ground can be affected by the combustion of fuel and by the respiratory action of living organisms, it appears to be constant in the upper air. From the figures obtained there follows a probable value of 0·025 ± 0·001 per cent. This figure is somewhat smaller than the carbon dioxide content of the sample obtained in the stratosphere over the American continent during the flight of *Explorer II*: this was found to be 0·029 ± 0·002 per cent[6] and seems to be the only reliable figure published so far of the carbon dioxide content in the upper air. But in view of the different analytical procedure and the lack of common standards, it would be premature to speculate whether this difference is due to the geographical position of Great Britain.

My thanks are due to the Director of the Meteorological Office, Air Ministry, for the collaboration afforded and for permission to publish these results, to Mr. L. H. G. Dines, who obtained the air samples by balloon sounding, and to Prof. F. A. Paneth, in whose laboratory this work has been carried out, for his constant interest.

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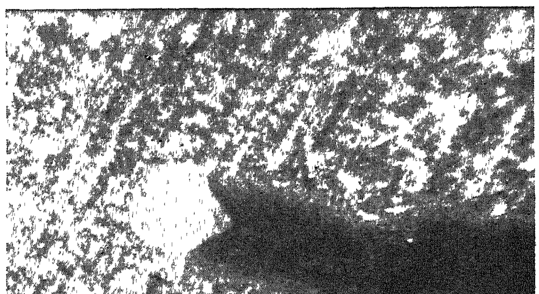
Filiform Underfilm Corrosion of Lacquered Steel Surfaces

IN the course of some work on the corrosion of steel plate surfaces coated with transparent oil-modified synthetic lacquers in atmospheres containing acetic acid and water vapour, the production and growth of the hair-like corrosion tracks known as 'underfilm corrosion' were observed under the microscope. It has been suggested that these corrosion tracks follow cracks in the oxide film separating the metal and the lacquer. The samples were prepared by cutting grids of one inch mesh through the lacquer coating with a razor blade. These were then exposed in a desiccator with a dish containing 5 per cent acetic acid for 24 hours, after which the acid solution was replaced by water.

It was found that the area of exposed metal was quickly covered with a layer of red oxide, and that, at a number of points along the edges of the cuts, radial corrosion started, producing areas under the film which were semicircular in shape and of slowly increasing radius. In some cases when two of these semicircular areas intersected, forming a cusp, a new type of 'filiform' corrosion was set up, which penetrated under the film at a relatively high speed (of the order of one inch per month under the conditions of the test). The tracks varied in thickness between 0·1 and 0·5 mm., but each was practically constant throughout its length. On highly polished sheets the direction of the tracks appeared to be random, although on unpolished mill sheets there was a preference for the direction of the grain of the steel.



The most interesting feature of this phenomenon is the structure of the growing head of the tracks, which is shown in the accompanying photograph with a magnification of 75. The sides of the cusp, of which the angle varies above and below 90°, are extremely sharp and suggest the existence of a membrane, possibly ferric hydroxide. This sharp boundary separates the rusty red track from a blue-coloured area bounded on its forward edge by a semicircular boundary. This appears in the photograph as a light-coloured space. The appearance suggests a bubble of liquid containing ferrous ions, the shape of the forward edge of the bubble being determined by the adhesion between the lacquer and the steel surface, and producing an effect similar to that of surface tension.

It would appear that this particular configuration constitutes a stable regime, which tends to extend the corrosion in the forward direction of the axis of symmetry of the cusp, but shows no tendency to extend in a direction at right angles. In this connexion it has been noticed that if the head of a track approaches an existing track, it is sharply deflected from its original direction, which indicates that the area on each side of an established track is unfavourable to this type of corrosion propagation.

Tracks have been observed with a length several hundred times their own width and still growing with no apparent decrease of vigour. This seems to suggest that the corrosive agent, in this case acetic acid, has been propelled forward undiminished in amount within the bubble as if by a sort of pumping action due to the advance of the V-shaped membrane. This suggestion is supported to some extent by the observation that if a razor cut is made in the lacquer across the path of a growing track, the filiform corrosion regime breaks down as soon as contact is made with the discontinuity in the lacquer.

This phenomenon is probably of very considerable importance in the corrosion of all painted steel surfaces, since it is capable of spreading fairly rapidly from the point of original damage of the film, although in highly pigmented paints the form of corrosion here described could not be observed visually.

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Physique and Perseveration

FOUR tests of perseveration[1], the 'S', 'Triangles', 'Mirror Image' and 'Alphabet-Number' tests, were given to 92 boys at the Polish Boys' College, Glasgow. The boys were also classified, according to Kretschmer's well-known types of physique, into four groups, the asthenic, athletic, pyknic and indefinite. The results of the four perseveration tests were pooled, and the whole group was divided into two parts on a scale of 100 equal steps between the lowest and the highest perseverators in the group. The following table was made.

Perseveration	Physique				Totals
	Asthenic	Athletic	Pyknic	Indefinite	
Low	99	23	47	9	178
High	69	21	89	11	190
Totals	168	44	136	20	368

If there were no influence linked with physique which affected perseveration, then the totals in the bottom row should by chance be divided between high and low perseverators in the proportions shown by the right-hand marginal totals. χ-squared calculated on this assumption is 21·15, and, with three degrees of freedom, the probability of such a distribution being obtained by chance alone is less than 0·01. From this it may be concluded that asthenic boys tend to be low and pyknic boys high perseverators, while athletics and boys of indefinite physique are as often high as low. It may be possible to discuss this unexpected conclusion more fully in another publication.

If the four perseveration tests are taken separately, the 'Mirror Image' and 'Alphabet-Number' Tests conform to the general result. The 'Triangles' test suggests that both asthenics and pyknics are high perseverators, and the 'S' test suggests that both are low. Athletics and boys of indefinite physique are indifferent in all four tests.

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Homo sapiens in Australia contemporary with *Homo neanderthalensis* in Europe

THE interesting article by Prof. Wood Jones[1] on the recently discovered Keilor skull and its bearing on the antiquity of man in Australia invites attention to the fact that *Homo sapiens* occurs in Australia in a Pleistocene deposit. I should like to stress an important implication of this discovery, namely, that if the age of the skull as suggested by Mahony[2] can be confirmed, a form of *Homo sapiens* existed in Australia when *Homo neanderthalensis* lived in Europe.

Mahony states that the skull was found 18 ft. deep in a river terrace which, at its end near the sea, has a surface height of 60 ft. above low-water mark, and he correlates this with the 40–50 ft. level of Tasmania, regarded by Edwards[3] as Last Interglacial. The altimetric agreement with the Main Monastirian (18·5 metre) sea-level of Europe and other parts of the world is even better, being exact within 2 ft. There is no question that the main Monastirian sea-level dates from the first half of the Last Interglacial, say, about 150,000 years ago. But since the evidence for the age of the Keilor skull is purely altimetric, it is highly desirable that some supplementary evidence be brought forward.

Now, in Europe, the Last Interglacial has furnished remains of *H. neanderthalensis* only[4], and there is ample evidence that *H. sapiens* replaced *H. neanderthalensis* during the first interstadial of the Last Glaciation, and in some areas later, by immigration. This has been recognized widely; it means that *H. sapiens* evolved outside Europe, either during the Last Interglacial or even earlier. This view has found support in the discovery of the *sapiens*-like Swanscombe skull fragment of Penultimate Interglacial age (about 250,000 years ago), and in the *sapiens*-like features observed in Neanderthaloids from Steinheim and Mount Carmel.

The discovery of the Keilor skull makes this suggested greater age of *H. sapiens* appear in a more definite light: if *H. sapiens* had reached south-east Australia by the middle of the Last Interglacial, he must have evolved, presumably in Asia, considerably prior to this date, that is, either very early in the Last, or more likely in the Penultimate Interglacial. The implications of the conclusion are far-reaching. We must expect to find further evidence for *H.* cf. *sapiens* in deposits of the Penultimate Interglacial. Australian man might be the comparatively pure descendant of the primordial stock of *H. sapiens*. His migration to Australia possibly took place as early as during the Penultimate Glaciation, while the sea-level was at its lowest[5]. The Upper Palæolithic culture, which is usually associated with *H. sapiens*, is perhaps much older in Asia than it has been found to be in Europe.

It is to be hoped that the Keilor discovery will

encourage further search for early man in Australia, and also in Asia, in the anticipation that other geologically datable remains and industries be discovered.

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Road Accidents and Research

THE persistence of road accidents is evidence of a sociological disorder. They are the painful symptoms, not the malady. An organized attempt to diagnose the disease has yet to be made. Even the symptoms (namely, the accidents) have hitherto been neither recorded nor analysed scientifically. Hence references to statistical records, though sometimes suggestive, are never convincing. The records hitherto have suffered from the directive given to them by a tendentious supposition—that accidents must be due to avoidable carelessness or malignancy. This was officially imputed to some drivers (road hogs); later to all drivers (lust of speed); later still to lack of care in *all* road users without exception (pedestrians, cyclists and drivers), that is, the whole community. Before blaming the 'human factor', inquiry should have been made as to whether the conditions in which road users have to move are such that no large group of human beings could, by taking any reasonable care, negotiate all the emergencies that present themselves.

At present, motor users negotiate them to the point that the average driver carries on through each thirteen years without being involved in more than one minor (injury) accident. It can indeed be shown that by no degree of care can any one driver, cyclist or walker avoid most of the collisions that befall him. This is quite simply because, on the road (unlike the sea or the air), most moving units are not called on or enabled to indicate their intended movement or change of movement.

Mr. M. W. Davies[1] remarks on the lack of correlation between the number of accidents and the number of vehicles in 1931–34. He mistakenly ascribes this "to the increase of accidents in Great Britain in the 'bad' years 1931–34". In fact, these were four 'good' years, but they were made to look 'bad' by an arbitrary change in the method of making the accident records introduced at that date. Every injury 'accident', however trivial, was ordered to be reported by the driver involved under severe penalties, whereas before that date only those were counted that were sufficiently serious to come to the notice of the police. In consequence, the numbers recorded went up with a bound while the fatal accidents, which were not susceptible of this magnification by order, decreased for the first time in history and very notably—from 6,222 to 5,628—in 1931; they remained reduced throughout these four 'good' years, although the number of vehicles increased by nearly 200,000, namely, from 2,237,474 to 2,416,908.

The proportionality of vehicles to accidents is not very relevant as soon as we trouble to probe into such other accident causes as the varying number of traffic units including pedestrians brought on to the roads by more hours of sunshine. Two drought years increased fatal accidents by many hundreds, albeit the general accident trend remained downwards for the four years in question.

The number of 'injured and killed' should not be counted as giving the number of accidents; in a study of accident causation, the accident ratio (that is, number of vehicle accidents per quantity of traffic flow) is all-important.

Among the most important safeguards for the utility of a committee for research into safe traffic flow are: (*a*) it shall not be a committee for research into accidents; (*b*) it shall not be representative of the Ministries interested, or of any road business, but solely of scientific and technical knowledge and skill; (*c*) the remuneration of its members shall not be via these Ministries. These were the safeguards wisely introduced by Lord Haldane when he formed the Aeronautic Advisory Committee of scientific men.

MERVYN O'GORMAN.

21 Embankment Gardens,
London, S.W.3.

[1] NATURE, 153, 330 (1944).

Application of the Principle of Maximum Effect

A REMARK by Mr. M. B. Donald on p. 298 of NATURE of March 11 could usefully be extended. The validity of the application of minimization and maximization to determine optima is not confined to chemistry or to branches of descriptive science and technology. Politicians balance intangible advantages qualitatively; but if the state of a material can be expressed in terms of numbers, a quantitative balance can usually be made by equating *dis*advantages. This can often be done arithmetically.

However, the null principle upon which real and philosophical balances depend sometimes requires more than arithmetic to obtain a scientific statement of a problem. If an empirical attempt is made to solve a problem that involves the null principle, it is merely a matter of chance whether the right solution is reached; hence the empirical approach leads usually to a loss of efficiency and not infrequently to an unintended result. Prof. R. A. Fisher has pointed out to me that that case of the null principle which I have called the principle of maximum effect can, in relation to the black-out, and in terms of lives only, be stated thus: The loss of life is least when the number of lives lost due to accidents and the like arising from any small reduction in lighting is equal to the number of lives gained due to the reduced assistance given to enemy action by the lighting visible to the enemy. Any departure from this results in avoidable loss of life.

The question of method in relation to effectiveness of invention has been discussed by Mr. C. Turnbull in articles in Vol. 15 (1942) of *Distribution of Electricity*. This series merits a wider publicity than can be given by a house organ. Many community relationships being based upon number and statistical distribution, or being otherwise amenable to scientific treatment, I suggest that there is sufficient material for an attack upon the general question of the application of scientific principle in its widest sense to problems of living.

HUGH NICOL.

35, Tennyson Road,
Harpenden, Herts.
March 25.

INDUSTRIAL RESEARCH IN INDIA

MR. J. J. GHANDY'S presidential address to the Section of Engineering and Metallurgy at the thirty-first Indian Science Congress, held at Delhi, on "Industrial Research, with Special Reference to India", reviews the development of industrial research in India and the work of the Board of Scientific and Industrial Research.

Mr. Ghandy said that the Control and Research Laboratories of the Tata Iron and Steel Company at Jamshedpur, completed in 1937, are specially mentioned as among the finest laboratories attached to any single steel-producing unit in the world; yet industrial research in India is still sporadic and unsystematized, although its importance as the chief instrument of progress increases. A review of the position and organization of research in Germany, Great Britain, the United States and the U.S.S.R. leads to the conclusion that the Government, universities and industry in India must be assigned distinct research functions although working in close collaboration. The Council of Scientific and Industrial Research should correspond to the Committee of the Privy Council for Scientific and Industrial Research in Great Britain, and consist of prominent industrialists, economists and scientific men with the main function of laying down broad principles of policy, co-ordinating activities and receiving financial grants from the Government.

The Board of Scientific and Industrial Research should concern itself largely with science, while the industrial application of scientific research would be the concern of the Industrial Research Utilization Committee. In Mr. Ghandy's view, the broad functions of the Board would be to plan national, scientific and industrial research in collaboration with the Industrial Research Utilisation Committee under the general direction of the parent Council; to develop facilities for executing the national research programme, by setting up laboratories for chemical, metallurgical, physical, fuel and food research, etc., stimulating the growth of private research institutes and laboratories and encouraging the American fellowship plan for this purpose; and to apportion research schemes to its own and private and university laboratories. It should also control, supervise and co-ordinate scientific research activities and technical education, thus ensuring proper collaboration between Government, industry and science; as well as distribute grants to research institutes and individual workers when necessary. It should formulate and submit its general recommendations annually to the parent Council for approval.

As at present, the Board should operate through a number of research committees, each committee being responsible for research in a particular branch of science, with a director of that branch as secretary. The Industrial Research Utilization Committee should be an industrial committee with much wider functions, co-operating with the Board on one hand in formulating a national research programme, for which it would provide the industrial basis, and on the other operating through a chain of industrial committees covering the different groups of industries. This Committee should also devise methods for the utilization of researches completed by the Board, and formulate rules regarding the taking out of patents and the collection and distribution of royalties. The Board of Scientific and Industrial Research should make its own laboratory facilities available to duly qualified workers, and allow industries to conduct research on specific problems with their own research workers in these laboratories on the lines of the American research associate plan.

Mr. Ghandy also suggested a supreme academy of sciences representative of private research associations and academies and eminent scientific men from the universities to collaborate with the Board in the general planning and direction of scientific research. The Board should provide the universities with financial assistance both for the extension of staff and laboratory facilities and for scholarships for post-graduate research, while the universities should give facilities for industrial fellowships for the investigation of specific industrial problems. The Government scientific services require strengthening, and while they should be given the fullest possible measure of autonomy, they should co-operate with the Department of Scientific and Industrial Research in the enunciation of policy. A scientific news agency and greater attention to publicity and the dissemination of scientific knowledge are also advocated.

TRUTH IN ANTHROPOLOGY

MR. VERRIER ELWIN has made notable contributions to anthropology in India. In his remarkable monograph on the Baiga, he has shown that he can get deeper into the life of a primitive tribe than any of his predecessors in that field, while his second monograph, on the Agaria, has shown that he is as well able to present the life of a primitive craftsman and iron-smelter as that of the primitive hunter, agriculturist and poet which makes a Baiga. It must be confessed, however, that his presidential address to the Section of Anthropology and Archæology at the Indian Science Congress at Delhi last January is far from being the happiest of his efforts. He calls it "Truth in Anthropology"; but the matter that follows the title puts one in mind at once of jesting Pilate, for it fairly bristles with controversial opinions stated dogmatically as truths. Worse than that, to allege, for example, that Frazer, Westermarck and Briffault have been influenced in any way by the political bias of their sources of information is a very improper and unjust imputation on the scientific integrity of three great men, of whom two at any rate are no longer alive to defend their reputations. To suggest of Briffault, of all people, that his "only standard of judgment appears to be political respectability", shows an ignorance of his work so profound as to make Mr. Elwin's strictures as worthless as they are deplorable. Let him take and read "Reasons for Anger" before he talks further of Briffault and political respectability. To decry the value of Frazer's work is, of course, rather the fashion, and those who do so rarely seem to have read what he wrote or to realize that, had he not written, it is doubtful whether they would ever have written either. Mr. Elwin adds nothing to his stature by swelling their numbers.

It is difficult after this to attach a great deal of importance to Mr. Elwin's attack on the Indian Census for classifying the primitive tribes of that peninsula as other than Hindu. It may be indeed, as he says, that Hinduism is an animistic religion, but even if all Hindus be animists, that does not make all animists Hindus. It is true that Hinduism is a receptive creed; that many of the most orthodox Hindus hold that all other creeds are mere back-

slidings from their truths. At the same time, he would be a bold man who would therefore label Christians, fireworshippers, Manichæans or Mormons, let alone Muslims, as Hindus. It may well be admitted that it would have saved a great deal of trouble to Census authorities if aboriginal tribes had all been included as Hindus; it must indeed be admitted that a nice discrimination of the point at which they become Hindu is difficult in many tribes which have sophisticated sections of their population entirely Hinduized while other sections remain primitive in belief and practice.

Yet the distinction which Mr. Elwin would apparently like to make between aboriginals and non-aboriginals is no easier to draw on racial or on cultural lines, and in the pursuit of truth in any event difficulty of attainment is neither here nor there. Mr. Elwin himself might just as fairly be suspected of a political or communal motive in advocating the return of aboriginal tribes as Hindus, as the Census officers are so suspected by him for trying to distinguish them from Hindus. It may be admitted that an entirely satisfactory criterion of Hinduism has not yet been found, but persons who do not observe caste, who disregard the religious authority of Brahmans, who do not hold the doctrine of *karma* can with difficulty be regarded as Hindus at all. One writer at the recent census of India—Mr. Webb, Census superintendent of Rajputana and author of "These Ten Years"—goes so far as to make untouchability actually the test of Hinduism in the case of tribes doubtfully within its pale. The Chamar, he says, is untouchable because he deals in cowhide and the flaying of cows, in pursuits, that is, defiling to a Hindu; the Bhil follows practices just as repugnant to a good Hindu, but he is not untouchable; this can only be because it is recognized that since he is not a Hindu, those practices do not put him beyond the pale of decent society. The contention has some force, even though many Bhils are undoubtedly Hindus.

The amazing statement, again, that the creation of Excluded and Partially Excluded Areas "was largely the work of a distinguished anthropologist at the Round Table Conference", even if it contains any portion of the truth, which may well be doubted, is very far indeed from being the whole truth. The areas referred to were administered under special regulations long before the Round Table Conference was even conceived of, and their so-called "creation" was a natural and, as administration officers saw it, an almost inevitable development in the process of applying the reforms to Indian political life. Anyone interested in pursuing the point might refer to Chapter 7 of Part ii of Vol. 1 of the Indian Statutory Commission's Report of 1930, and to Chapter 2 of Part iii in Vol. 2.

There are other very questionable statements of a similar kind. In one case a writer is quoted as expressing an opinion, and then taken to task for giving information. But what he gave was a statement not of fact but of an opinion derived, perhaps quite legitimately, from such information as he did succeed in obtaining. The adjective "Tylorian" is used as a derogatory epithet—and so forth. All of which is a great pity, for Mr. Elwin has something to say, and we agree with him entirely in his statement that "truth in anthropology demands a scrupulous adherence to the highest rules and standards in field-work". No doubt presidential addresses are not fieldwork, but that is no ground for any relaxation in them of the high rules and standards of a scientific approach, nor for the imputing of disingenuous motives to workers whose outlook and views prove unpalatable to the temporary occupant of the chair.

J. H. HUTTON.

PARASITIC DISEASES OF MAN IN RELATION TO THE WAR

FIVE addresses given to a conference on parasitic diseases held by the New York Academy of Sciences in March 1943 have been published (*Ann. New York Acad. Sci.*, 44, Art. 3, 189–262; 1943). In his introductory address, Prof. H. W. Stunkard points out that the study of animal parasites is no longer an academic one, because the diseases they cause constitute one of the most pressing problems of to-day and to-morrow. The gravity of the problem is increased by the dispersal of American (and, we would add, other) troops to all parts of the world, where they are acquiring parasitic diseases. These troops may, both now and after the War, bring back to their home countries parasites not normally prevalent there. Not all these parasites will be able to spread in these home countries, either because the local climatic and other conditions are not favourable to them or because the intermediate hosts necessary for the completion of their life-histories do not exist. But it is known that some parasites have been able to acquire new intermediate and definitive hosts in countries to which they have been transported. Prof. Stunkard gives as an example of this the sheep liver fluke, and he considers the possibility that the human schistosomes may, for example, acquire the ability to develop in some snail in America. The risk of the introduction of new parasites into the home countries is real enough to require energetic action. We in Great Britain, with much colonial and tropical experience to guide us, have been always aware of it; and it is evident that the United States' authorities have also taken the problem in hand.

Already during this War parasites have done appreciable harm to both Allied and Axis troops. Trichiniasis has put out of action at least one battalion of German troops in Norway (*Bull. War Med.*, 3, 236; 1942), and German commando and other troops have suffered from this disease on their Eastern front. We know also something of the precautions taken by the Germans to protect their Afrika Korps from disease in Egypt and the tropics. Their problems would seem to be now solved for them by the removal by the Allies of all possibility of the entry of Axis troops into the tropics.

For the Allies, however, these problems increase as their victories extend. Prof. Stunkard states that it has been reported that the United States' defeat at Bataan was due as much to the malarial parasite as to other causes. He estimates that a million or more United States troops may acquire parasites and that their fighting efficiency may be proportionately reduced. Dr. Coggeshall, dealing with current and post-war problems associated with human Protozoan diseases, says that United States troops are already acquiring Protozoan infections from native reservoirs at an alarming rate. Amœbic dysentery and malaria are the chief dangers in this field, although other parasites (for example, the trypanosomes) must not be forgotten. Malaria, which is one of the major enemies of both sides in war, can persist in man for

years, especially if it is quartan malaria. Dr. Coggeshall cites the case of a Greek who acquired quartan malaria in Greece and, after thirty-seven years in Denver, gave his blood for blood transfusion and communicated quartan malaria to the recipient of it. Dr. Matheson, at the same meeting, recorded the transmission of the parasite of malignant tertian malaria (*Plasmodium falciparum*) to a six-year-old child in Ithaca, N.Y., through receiving a blood transfusion from her father, who had never shown symptoms of the infection. E. L. Lozner and L. R. Newhouser (*Amer. J. Med. Sci.*, **206**, 141–146; 1943; and *Bull. War Med.*, **4**, 353; 1944) conclude that there is no likelihood of the transmission of malaria by blood *plasma* used for transfusions. They did, however, transmit malaria to two out of 35 recipients of plasma taken from patients infected with either quartan or malignant tertian malaria, but the plasma given to these two cases had been preserved for only one day in the liquid state. Malaria was not transmitted when the plasma of malarial patients was preserved in the liquid state at room temperature for two weeks, or when it was either frozen and then stored at − 20° C. or dried from the frozen state.

The control of the vectors of malaria is another important problem. *Anopheles quadrimaculatus*, which can transmit all three human species of the malarial parasite, is the chief vector of malaria in the United States and is abundant as far north as the Canadian border. The corresponding malarial problem in Great Britain has been considered by Sir A. McNalty (NATURE, April 17, 1943, p. 440), and the British species of mosquitoes and their control are dealt with by Lieut.-Colonel Sinton and P. G. Shute (*Min. of Health Mem. Med.*, 238; 1943). J. F. Marshall (NATURE, **149**, 568; 1942) and Dr. A. B. Williamson and J. F. Marshall (*Brit. Med. J.*, Sept. 11, 1943, p. 332) have studied the breeding of mosquitoes in war-time static-water tanks in Britain. The damage that malaria can do to armies in the field is indicated by the figures given by Dr. T. T. Mackie in his address in the American symposium on the clinical features of parasitic diseases. To give only one example of these, Mackie says that the French force of 120,000 men in Macedonia in 1916 was reduced by malaria to an effective field force of only 30,000, that the British Macedonian force had 30,000 malaria cases in 1916 and 70,000 in 1917, and that the Germans had similar losses; so that Plasmodium alone immobilized these armies.

Problems of control among large numbers of people are difficult enough in times of peace. These difficulties are increased in war-time, and added difficulty is introduced by rapid transport. The aeroplane itself may introduce infected hosts and vectors of all kinds of diseases (Jackson, W. P., *Virginia Med. Monthly*, **69**, 29; 1942; and *Bull. War Med.*, **3**, 629; 1943). Coggeshall points out that practically all the foreign air traffic to the United States, except that to and from Great Britain, originates in the tropics, where airports are usually in places in which sanitary measures are inadequate or absent; these airports are also surrounded by native villages the inhabitants of which are used as labourers and who are infected. The risks involved are exemplified by the accidental introduction in 1930 of *Anopheles gambiæ* into South America; this was followed by an epidemic of malaria which caused 100,000 cases and a minimum of 14,000 deaths. The insect was eradicated by the joint efforts of the Brazilian Government and the Rockefeller Foundation (Soper, F. L., and Wilson, D. B., *J. Nat. Malaria Soc.*, **1**, 5; 1942 and *The Lancet*, Jan. 22, 1944, p. 120). Failure to perform this difficult feat might have resulted in disaster to all the tropical areas of the western hemisphere.

Coggeshall's further remarks on the virulent malaria and dysentery seen by him among Poles coming out of Russia to Persia in 1942, and the risk of their spreading these diseases to India, East Africa and other places to which they were dispersed, make clear the risk inherent in mass migrations of peoples, especially if, as is scarcely avoidable in war-time, they are in poor health and encounter strains of a parasite to which they are not accustomed. Such strains produced, after the War of 1914–18, secondary epidemics of malaria in England, Germany (6,000 cases) and Russia (3 million cases west of the Urals, half the population of Georgia and the deaths of two-thirds of the population in villages near Tiflis). These figures recall the ravages of typhus and plague, and remind us that the vectors of disease caused by bacteria and viruses may also be carried by aeroplane. This aspect of the problem was dealt with in an address by Dr. R. Matheson on "Arthropods as Vectors of Human Diseases". So far as malaria is concerned, we should do well, says the *Lancet* (March 18, 1944, p. 380), to be warned by the experience of France, where malaria, introduced in 1939 by infected Spanish refugees, has persisted since that date in the Canet and Saint-Cyprien regions of the Pyrénées-orientales.

That the French National Committee of Liberation is already tackling the problems of the parasites, as well as those of other diseases, in the French African Colonies, is indicated by a special medical section of the Brazzaville Conference (*The Lancet*, April 1, 1944, p. 440). The proposals made include the creation of large mobile units to seek out and treat illness and deal with problems of sanitation, and the establishment of a central institute of hygiene and research and, after the War, a medical school and an international bureau of public health.

Dr. N. R. Stoll, taking as the title of his address "Changed Viewpoints in Helminthic Disease: World War I vs. World War II", gives a summary of modern views on the control of hookworms, Trichinella, tapeworms, the flukes of the Orient and other helminth parasites. He outlines our changed views on the epidemiology of diseases caused by this kind of parasite and on human resistance and immunity to them. Stoll quotes Leiper's list of facts (*Brit. Med. J.*, July 19, 1924, p. 110) about the helminth which the public health worker should remember. Helminths do not multiply within the human body; their eggs or embryos have to leave the human body and are not infective to man when they leave him, but have to undergo first a development outside man, either in the outside world or in an intermediate host; the environment necessary for this development varies with different species; the helminth enters man by the mouth or by penetration of the skin and many species then have to make extensive journeys inside the human body; few helminths are specific to man and their spread can be prevented by breaking the life-cycle. The knowledge gained about helminth parasites during recent years should, says Leiper, enable us eventually to eradicate helminth infestations of man, if it is properly used. A big "if", some would say; but the task is possible. Under the conditions which we may expect after the War, it will indeed be formidable.

G. LAPAGE.

HIGH-VOLTAGE CIRCUIT-BREAKER TECHNIQUE

Two important papers were read in London before the Institution of Electrical Engineers on March 30, one on restriking voltage as a factor in the performance, rating and selection of circuit-breakers, by Messrs. J. A. Harle and R. W. Wild, and the other on the influence of resistance switching on the design of high-voltage air-blast circuit-breakers, by Messrs. H. E. Cox and T. W. Wilcox.

In the first of these, Messrs. Harle and Wild point out that the behaviour of circuit-breakers when breaking short-circuit currents depends on a number of factors which include circuit power-factor, recovery voltage, earthing conditions, and current asymmetry. A further condition of severity is the restriking-voltage transient and its attribute, the rate of rise of restriking voltage. The paper shows the effect of this severity factor on the performance of plain-break oil circuit-breakers, oil circuit-breakers fitted with arc-control devices, and air-blast circuit-breakers. Compared with the relatively small effect that rate of rise has on plain-break and arc-control oil breakers, its importance for the performance of air-blast breakers is emphasized, and recommendations are made for its utilization in the rating, testing and selection of these breakers.

The conclusions reached may be summarized as follows. Plain-break oil circuit-breakers and oil circuit-breakers with arc-control contacts are relatively unaffected by the rate of rise of restriking voltage and hence the specification of its value is not essential, provided the circuit-breakers are tested in accordance with British Standard 116 under the severity conditions of the Association of Switchgear Testing Authorities. In air-blast circuit-breakers it is essential to take account of the rate of rise of restriking voltage when rating, testing and selecting, and in consequence they must be rated in terms of megavolt-amperes at a rated voltage and at a rate of rise of restriking voltage. Methods are proposed for specifying minimum rates of rise of restriking voltage for each megavolt-ampere rating and voltage, the adoption of which enables an economic range of switchgear to be designed which will meet all average conditions of severity in service and permit economic selection of circuit-breakers to be made.

A simple method of checking the suitability of any breaker rated as above for normal conditions of service is given, together with data for checking the suitability of any breaker for more unusual conditions of service. The method involves calculating the fault megavolt-amperes in the usual manner and checking that the proportion of the fault megavolt-amperes contributed locally by generators, transformers, and the like, is not in excess of an amount appropriate to the breaker rating. Circuit-breakers rated in the manner advocated can also be selected for more severe conditions by adopting the methods described for reducing circuit severity in service. Proposals are made for testing air-blast circuit-breakers, including synthetic tests for certain types of high-voltage circuit-breakers the megavolt-ampere ratings of which are in excess of testing station outputs.

In the second paper, Messrs. Cox and Wilcox review the various problems which are met in designing high-voltage circuit-breakers, and the way in which the application of resistance switching confers another degree of freedom upon the designer in meeting the many conflicting requirements. It is first shown that a circuit-breaker must not only break its rated breaking current, but must also limit the value of surge voltage which it causes while it is opening the circuit. This can be brought about by limiting the electric strength of the breaker contact gaps.

An experimental method of determining the electric strength of the nozzles under air-flow conditions is explained, followed by a discussion of the means by which resistance switching enables the designer to control both the nozzles independently. A 132-kV. breaker designed in conformity with the conclusions reached is described and test results are given for a full-scale test equipment. The paper then gives an analysis of the validity of 'unit testing' as applied to multi-break breakers with resistance switching, as compared with the use of the present two-part testing applied to oil circuit-breakers in accordance with British Standard 116, part 2. Finally, proposals are made for a series of type-test duties to be applied to air-blast circuit-breakers, in order to prove compliance with their breaking-capacity ratings.

The conclusions reached by Messrs. Cox and Wilcox are as follows. An air-blast circuit-breaker, like an oil circuit-breaker, causes over-voltages when it breaks a circuit under certain conditions. The prospective value of the over-voltage depends upon the circuit constants and upon the rate at which the arc is de-ionized. Under conditions very often realized in practice, the prospective value of such over-voltage can be dangerously high, and the actual value reached is limited only by restriking of the breaker gap. The latter thus not only has to be proportioned to break its rated breaking current, but also to limit, by restriking, the values reached by switching over-voltages. The breaker capacity and electric strength of a nozzle are interdependent, unless the restriking-voltage transient can also be controlled. The latter can be modified by means of resistance switching, so that by its introduction the breaking capacity and electric strength of the breaker can be controlled individually and independently.

By combining resistance switching with series multi-breaks, the distribution and exact shape of the restriking transient across each break can be controlled accurately. Thus 'unit testing' of such breakers is completely valid. This will greatly increase the scope of existing test plants for testing high-breaking-capacity breakers. The breaking-capacity type tests given in British Standard 116 for oil circuit-breakers are not entirely satisfactory for air-blast breakers. Among several minor changes it is necessary to add a test duty to prove that the breaker adequately limits switching over-voltages. The switching over-voltage which is most convenient to produce on test plants is that due to current-chopping in an inductive circuit. The voltage-limiting effect of the breaker can be demonstrated by taking a series of breaking tests at a current at which multiple current-chopping occurs. A duty comprising only three tests is considered inadequate to demonstrate the capability of the breaker to limit over-voltages, and it is suggested that twenty tests should be included. These should be sufficient to take care both of the variations in arc length at final interruption and also the statistical nature of the breakdown of air-gaps under rapidly applied voltages.

FORTHCOMING EVENTS

Saturday, May 20

NUTRITION SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, Gower Street, London, W.C.1), at 10.30 a.m. —Conference on "Budgetary and Dietary Surveys of Families and Individuals", Part 2 (to be opened by Prof. V. H. Mottram, Mrs. Barbara Callow, Dr. C. P. Stewart and Miss M. C. Broatch).

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 2.30 p.m.—Annual General Meeting; at 3.15 p.m.—Prof S. Russ: "The Man Silvanus Thompson" (Twenty-third Silvanus Thompson Memorial Lecture).

INSTITUTE OF PHYSICS (joint meeting of the INDUSTRIAL RADIOLOGY GROUP and the MANCHESTER AND DISTRICT BRANCH) (in the Physics Department, The University, Manchester) at 2.30 p.m.—Mr C. T. Snushall: "Filters and Intensifying Screens—their Applications in Light-Alloy Radiography".

Monday, May 22

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. R. W. Moore: "Visual Education".

Tuesday, May 23

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the CHEMICAL ENGINEERING GROUP and the INSTITUTION OF CHEMICAL ENGINEERS) (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. J. E. Hurst: "Improvements in Acid Resisting Silicon Iron Alloys".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Dr Margaret Hadley Jackson: "A Medical Service for the Treatment of Involuntary Sterility".

Wednesday, May 24

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—The Rt. Hon. the Earl De La Warr, P.C.: "Flax Production in War, and its Prospects in Peace".

PHYSICAL SOCIETY (in the Physics Department of the Imperial College, Imperial Institute Road, South Kensington, London, S.W.7), at 5 p.m.—Dr. W. S. Stiles: "Current Problems in Visual Research."

Thursday, May 25

BRITISH INSTITUTION OF RADIO ENGINEERS (LONDON SECTION) (at the Institution of Structural Engineers, 11 Upper Belgrave Street, London, S.W.1), at 6.30 p.m.—Dr. Hilary Moss: "The Electron Gun of the Cathode Ray Tube", Part 1: "Limitations in its Performance".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

DRAINAGE AND IRRIGATION ENGINEER by the Gambia Government —The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E. 950 A) (May 24).

LECTURER IN ELECTRICAL ENGINEERING, and a LECTURER IN MECHANICAL ENGINEERING with special reference to Workshop Technology or Heat Engines—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (May 25).

LECTURER in charge of the DEPARTMENT OF BOTANY—The Registrar, University College, Leicester (May 27).

LECTURER IN ELEMENTARY SCIENCE AND PHYSIOLOGY at the Chelsea College of Physical Education (temporarily evacuated to Borth, near Aberystwyth)—The Principal, Chelsea Polytechnic, Manresa Road, London, S.W.3 (May 27).

LECTURER IN ENGINEERING SCIENCE at the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (May 29).

TECHNICAL ASSISTANT IN AGRICULTURAL ECONOMICS—The Acting Registrar, The University, Leeds 2 (May 30)

ASSISTANT MASTER or MISTRESS to teach MATHEMATICS, with some SCIENCE, in the Junior Technical School of Engineering of the Willesden Technical College, and possibly some MATHEMATICS in Part-time Day Courses—Dr. E. Davies, Education Office, Vernon House, 163 Willesden Lane, London, N.W.6 (May 31).

SCIENCE TEACHER, with primary qualifications in Physics or in Chemistry, a TEACHER OF MATHEMATICS, and a LECTURER in ENGINEERING SUBJECTS, at the County Technical College, Stafford—The Director of Education, County Education Offices, Stafford (May 31).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

DEPUTY ENGINEER of the Sheffield Waterworks Undertaking—The General Manager and Engineer, Waterworks Office, Town Hall, Sheffield 1 (May 31).

CHAIRS OF PHILOSOPHY, ZOOLOGY and COMPARATIVE ANATOMY—The Registrar, University College, Cathays Park, Cardiff (May 31).

ENGINEER AND SURVEYOR to the Esher Urban District Council—The Clerk to the Council, Council Offices, Esher, Surrey (endorsed 'Engineer and Surveyor') (May 31).

DEPUTY CHIEF ENGINEER (location, City of Manchester)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.834XA) (May 31).

LECTURER IN THE MECHANICAL ENGINEERING DEPARTMENT—The Director, Robert Gordon's Technical College, Aberdeen (May 31).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN CHEMISTRY —The Principal, Royal Holloway College, Englefield Green, Surrey (May 31).

BACTERIOLOGIST on the staff of the Water Pollution Research Laboratory of the Department of Scientific and Industrial Research—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2248A) (May 31).

CHAIR OF BOTANY—The Registrar, The University, Sheffield (June 1).

LECTURER IN BIOLOGY to take Nature Study with Froebel students, Biology with advanced class, and to train post-Graduate Biology students—The Principal, Maria Grey Training College, at the Training College, Castle View, Dudley, Worcs. (June 1).

LECTURER FOR PRACTICAL MATHEMATICS and MECHANICS, LECTURERS (2) for MECHANICAL ENGINEERING, and a LECTURER for ELECTRICAL ENGINEERING, in the Department of Engineering—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (June 5)

DEMONSTRATOR (man or woman) IN THE PHYSIOLOGY DEPARTMENT —The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, Brunswick Square, London, W.C.1 (June 9)

ENGINEER AND MANAGER of the Manchester Waterworks Department —The Secretary, Waterworks Department, Town Hall, Manchester 2 (June 10).

INSPECTORS (temporary) by the Board of Education (1) MECHANICAL OR ELECTRICAL ENGINEERING (Reference No C 2125A), (2) AERONAUTICAL ENGINEERING (Reference No C.2124A)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (June 10).

LECTURERS to take the following subjects for Evening Classes up to Matriculation standard: ELEMENTARY MATHEMATICS, GEOGRAPHY, CHEMISTRY, PHYSICS, BIOLOGY, LOGIC—The Director of Education, The Polytechnic Regent Street, London, W.1 (June 12).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

ASSISTANT HYDROGRAPHIC SURVEYORS by the Kenya Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No.E.904A) (June 17).

ENTOMOLOGISTS in the Medical Departments of Uganda, Northern Rhodesia, and the Tanganyika Territory, for general entomological work; with special emphasis on the investigation of tsetse fly and mosquito problems in the field as well as in the laboratory—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F 2421A) (June 17)

LECTURER IN ENGINEERING in West Africa—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.836A) (June 21).

ENGINEERING DRAUGHTSMAN for the Department of the Comptroller of Development and Welfare, West Indies—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1373).

WORKSHOP STEWARD (temporary) for the maintenance of the ENGINEERING AND BUILDING WORKSHOPS—The Principal, Municipal College, Southend-on-Sea.

TECHNICIAN mainly for research work, experience in histological technique essential—The Registrar, King's College, Newcastle-upon-Tyne.

HEAD LABORATORY STEWARD (man or woman) in the DEPARTMENT OF PHYSICS AND TELECOMMUNICATIONS—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

HYDROGRAPHICAL SURVEYORS for the Basrah Port Directorate, Iraq—The Ministry of Labour and National Service, Appointments Department, Sardinia Street, Kingsway, London, W.C.2 (quoting Reference No. O.4962S).

ADMINISTRATIVE ASSISTANT (male) in connexion with the scheme of the Ministry of Agriculture and Fisheries for the provision of technical advice to farmers—The Dean of the Faculty of Agriculture and Horticulture, The University, Reading.

TEACHER (man or woman) of CHEMISTRY and BIOLOGY—The Principal, Technical Institute, Longport Street, Canterbury.

TEACHERS (2, full-time) of ENGINEERING SUBJECTS to help with the development of Higher National Certificate courses—The Principal, Technical Institute, Gravesend.

MASTER for ENGINEERING SUBJECTS (MECHANICAL), including Engineering Drawing, and a MASTER for MATHEMATICS and MECHANICS—The Principal, Erith Technical College, Belvedere, Kent.

LECTURER IN BACTERIOLOGY to students preparing for the National Diploma in Dairying—The Principal, Studley Agricultural College for Women, Studley, Warwickshire.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Licorice—Putting a Weed to Work. By Dr. Percy A. Houseman. (Twenty-sixth Streatfeild Memorial Lecture.) Pp. 16. (London: Royal Institute of Chemistry.) [264

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 808, Vol. 239: Relaxation Methods Applied to Engineering Problems, 9: High-Speed Flow of Compressible Fluid through a Two-dimensional Nozzle. By Dr. J. R. Green and Prof. R. V. Southwell. Pp. 367–386. (London: Cambridge University Press.) 3s. [264

Office of the Minister of Reconstruction. Welsh Reconstruction Advisory Council: First Interim Report. Pp. 132. (London: H.M. Stationery Office.) 2s. net. [274

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RECRUITMENT AND TRAINING OF TEACHERS

YOUTH LEADERS AND TEACHERS IN YOUNG PEOPLE'S COLLEGES

IN the second part of the McNair Report* it is significant that the sections on the supply, recruitment and training of youth leaders and teachers for young people's colleges have been grouped together. This implies a clear recognition that if the young people's colleges are to be successful, the more formal methods of the preceding school period will have to be dropped, and some of the spirit of informality which accompanied the growth of the youth movement and which has kept it vigorous and attractive will have to be preserved. Further, since the two services deal with approximately the same groups of young people, one attempting to meet their needs on the basis of compulsory and the other on the basis of voluntary attendance, Sir Arnold McNair's Committee insists that the foundations of the youth service must be laid during the years immediately following the break with full-time attendance at school.

Any attempt to draw up detailed proposals for the young people's colleges, which are not yet in existence, would have been a misuse of the Committee's time and energy, and it has therefore confined itself to a statement of broad principles.

Although the youth service differs in that it has a history, it presents a peculiar problem because, while that history has been in the main a story of voluntary initiative, to-day it is being woven into the pattern of education for which public authorities are responsible. This involves co-operation between voluntary and statutory bodies of a kind which calls for adjustment and tolerance rather than rigid rules and, if organization merely becomes an end in itself, its existence as part of the national system of education will be extremely precarious.

Many youth workers are anxious about what they call the 'professionalization' of work among young people and believe that it may result in a loss of spontaneity and freedom which is characteristic of the best voluntary work. The Committee strongly emphasizes that these fears about 'professionalization' will only be falsified if the quality of men and women recruited to the service of youth is sufficiently high to maintain the best of its traditions, and if statutory and voluntary bodies co-operate to put the needs of young people first and to leave administration and standardization to find their proper, but subsidiary, place.

Work with young people is so varied that those engaged in it can be classified in many ways. Two broad divisions are recommended in the report. First, full-time workers such as organizers, wardens and heads of large centres or institutions, who are almost invariably paid workers, and secondly, part-

* Teachers and Youth Leaders. Report of the Committee appointed by the President of the Board of Education to consider the Supply, Recruitment and Training of Teachers and Youth Leaders. (London : H.M. Stationery Office.) 2*s*.

time workers who may be paid or unpaid. In outlining a scheme for the training of youth leaders it must be recognized that this will in no way reduce the need for a tremendous number of voluntary workers to whom the service of youth owes its inception and high traditions.

The Committee points out that there is no recognized qualification for a youth leader, and there are few courses of systematic training. In the past these have been provided by the voluntary organizations and vary in duration from a few months to two and a half years. As a result of all these courses not more than 150 trained workers have been produced. Since the outbreak of war, the Board of Education has taken a hand in the sphere of training. Some of its staff have themselves conducted a number of short courses lasting from one to two weeks, and also in 1942, the Board announced its willingness to grant financial assistance on a student capitation basis to institutions and organizations which were prepared to conduct approved courses. These courses were to be regarded as experimental and were not to lead to a recognition of any course as providing a full qualification for youth service work (Circular 1598).

These different types of courses, for which more than three hundred students have enrolled, are serving a three-fold purpose. A number of war-time youth workers are being given a better background of knowledge and experience ; a variety of organizations are experimenting in the new field of training, and, equally important, the Board of Education, local education authorities, the universities, training colleges and voluntary organizations are being brought together in the work of training. The experiences gained from these courses will be invaluable in the framing of future ones leading to the attainment of nationally recognized qualifications.

Another anomaly in the service of youth which the Committee underlines is the lack of a national scale of salary. Current educational journals include advertisements ranging from £100 (with board) to £250 for youth leaders and wardens and £200–£400 per annum for organizers. There is great disparity in the salaries offered for comparable posts, and provision for pensions for youth service workers as such do not exist. Even the maximum salaries offered at present are not sufficiently high to attract the best type of personnel for this all-important work.

The age of entry to work in the youth service varies between wide limits. Since the service of youth caters for young people ranging from fourteen to twenty years of age, it is essential that there be corresponding maturity on the part of those who may be called upon to guide and advise them. It is important, too, that the wide field from which youth leaders and organizers are at present drawn should not be restricted. Among part-time and voluntary workers there are few professions which are not somewhere represented. Whatever system of training is devised for youth leaders, this invigorating variety must be preserved.

With these general considerations as a working basis, the Committee then discusses and makes various recommendations on the future supply and training of youth leaders.

On the assumption that one leader will be required for about every three hundred boys and girls between fifteen and eighteen years of age, it is estimated that 5,000–6,000 full-time youth leaders will be required. Since physical activities constitute a very important part of the interests of youth, and since many other activities which young people pursue with zest make great physical demands on those older people who help to plan them, it is reasonable to assume that the active working life of the youth leader will be less than that of the teacher. Adding to this the normal depletion through death, illness or premature withdrawal to other types of work, it is anticipated that, once the full establishment is in being, an annual recruitment of about three hundred youth leaders will be required. The Committee rightly indicates that "this flow of 300 a year will not be achieved without the establishment of a profession involving approved courses of training of a satisfactory standard which lead to a recognised qualification and of a service in which adequate salaries are paid and acceptable conditions of service are secured".

Training is regarded as essential, although it may not be practicable to make it compulsory in the immediate future. The youth leader works with human material, and the unguided experience through which he now has to learn his profession is only too often bought at the expense of those whom he seeks to help. Moreover, complete absorption in work with young people to the exclusion of a personal life of his own is one of the temptations that beset a leader, and his education should give him something which minimizes the danger of his becoming unduly preoccupied with youth. The leader, like the teacher, should be a well-balanced, fully developed individual.

At the time of his first appointment to a post, it is suggested that the youth leader should have achieved a fairly high standard in some field of knowledge or in some craft of his own choosing. He should have a good working knowledge of the elements of citizenship. He should possess considerable understanding of the psychology of young people and their individual, social and industrial background, as well as a genuine interest in one or more of the many activities in which young people freely engage, such as music, drama, crafts of all kinds, gymnastics, games, and so on. It is essential, too, that he should have some experience of actual work with young people, including what is involved in the organization and business management of groups, clubs or institutions. Most important of all, he must be the kind of man whose personality is acceptable to young people and who has a genuine sense of vocation for his work.

For the beginner it is recommended that the training course should extend over at least three years. At least a quarter, and in some cases a half, of the course should be practical work, and should not mean merely a series of brief visits of observation to a number of institutions concerned with young people. It should include substantial periods of continuous

work in one or more institutions or among one or more groups of young people in different geographical and industrial areas. In order to minimize a possible lack of coherence in such training, a full-time tutor should be responsible for planning the study and practice of a defined and small group of students. Ideally, each course, because of its practical nature and the co-operation with active youth workers, should itself be a contribution to the youth work of the locality, and the training system as a whole should influence the work throughout the country.

The institutions offering courses of training should keep continuously before them the need for devising the proper machinery of selection. A new entrant to the training courses might either be tried out in some youth service work before he makes a firm application for training, or might be given a preliminary interview sufficiently in advance of the beginning of the course to enable him to do some practical work prior to a final decision being reached about his suitability for training. The first term or two of the training course should be regarded as probationary. An important and long-sighted recommendation is that a student's achievements during training and his fitness for full-time professional work should not be decided by the results of an examination at the end of the course. The core of the assessment must be the capacity to live and work with young people. As a great deal of experimental work is already in progress, the Committee strongly recommends that the Board of Education should obtain an intimate knowledge of the conduct and results of the present emergency courses which are being aided under Circular 1598. Much guidance for the future might be obtained if the experience of those conducting these courses was pooled, analysed, and made generally available. A mass survey of the type of training essential, with the help of existing organizations already in touch with the country's youth, for example, the Central Council for Health Education and youth organizations, might well be initiated now.

The minimum age at which a man or woman should in normal circumstances take up full-time work must be carefully considered. Maturity is the essence of the problem when dealing with boys or girls or young men and women of 15–20 years of age who have reached, or are on the way to, economic and social independence. The psychological and social problems with which a leader has to deal differ profoundly from those which face a teacher in a primary school or even a secondary school. As a general rule, therefore, local education authorities and voluntary organizations should not appoint young men and women to full-time posts before the age of twenty-three.

Shorter courses of training are recommended for potential youth leaders who have already achieved knowledge and experience which is relevant to their personal life or to their professional competence as youth leaders. These will include university graduates, holders of social science diplomas, men and women who have had considerable practical experience as part-time youth leaders and wish to qualify for full-time work, and business or professional men and women who may be unfamiliar with the structure of society as it affects young people or who need some stimulus to the revival of his or her cultural interests. Save in exceptional circumstances, no course of training should be less than one year.

For some years after training, the youth leader—or teacher—would be expected to serve in the capacity for which he has been specifically trained. If, after some years of experience, a youth leader—or teacher—seeks to transfer to another part of the educational field, and is suitable, he should be enabled to do so. Since the course of training which is proposed for youth leaders is comparable in content, standards and length with that proposed for teachers, it is necessary that the salaries of youth leaders should be comparable with those of teachers, and that service as a youth leader should be pensionable. Transfer from one service to the other should be facilitated by the necessary linking of superannuation arrangements and the provision of suitable short courses of training.

During their training, youth leaders should not be segregated. If properly representative of the interests of youth, the area training authority, which the Committee recommends as the organization responsible for the training of teachers, is also the right body to plan and provide courses of training for youth leaders. The universities, technical colleges, schools of art and training colleges are all accustomed to the maintenance of standards in their own field, and they must see that in academic subjects, in social studies, in crafts and skills, the standards of youth service training are built up and maintained at a high level. The Committee further recommends that each area training authority should be adequately representative of youth organizations and should appoint a person qualified to direct such training for leaders in the youth service as the area is called upon to provide. The first five years of the training should be regarded as an experimental period and, for the time being, the Board of Education should recognize the appointment to full-time posts of those who have not been trained, but are deemed otherwise to be suitably equipped.

To return to the training of teachers for young people's colleges. If these colleges are not to be subordinated to the fluctuating needs of industry and commerce and to the frequently narrow requirements of the 'jobs' which young people are doing, the periods when the young people attend them must be regarded primarily as educational periods during which young people are also at work, finding their feet in industry, commerce, agriculture or domestic activities. Only if these periods are regarded as educational will the colleges develop into institutions calculated to inspire loyalty and affection from young people generally.

With this consideration in mind the Committee discusses the problem of the staffing of young people's colleges. It is estimated that the colleges will require the services of about twenty thousand teachers, involving, on the basis of one day's attendance a week,

a replenishment of about a thousand a year. How should they be recruited and how trained?

Young people's colleges, some of which may be residential, will be self-contained institutions, each with its own staff. They will be full-time institutions with, for the most part, full-time staff, but providing for students who will attend only part-time, and that under compulsion. This situation will present many difficult problems of organization and will complicate the planning of courses of study and activity. The uniform characteristic of the students will be that they are at work earning their living, or, if not at work, living at home and elsewhere in a state of semi-independence compared with the restrictions imposed when they were in full-time attendance at school. This change of status must be taken into account in the staffing of young people's colleges, but, on the other hand, its significance should not be exaggerated.

For young people's colleges, particularly, specific arrangements should be made for entry to the teaching profession of those who have had experience in some other profession or occupation. A rich field of recruitment will be the Service men and women, who have been labouring under great difficulties and yet built up a scheme of adult education the elasticity and breadth of which Great Britain has not seen before. These men and women will be eminently suitable for young people's colleges. Local education authorities should see that their experience is used to the full.

But while the staffs of young people's colleges will need to be persons with a wider experience of the world than is usual among the main body of teachers, the colleges will also require teachers with good qualifications in English, history, science, music, art, physical training, etc., as well as highly qualified teachers of technological and commercial subjects. It would be unwise to regard the colleges as institutions in which there is no place for the teacher with normal secondary or other school experience, or as institutions which require a kind of music or physical education wholly different in character from that to be found in other types of school or college. The staffing needs of young people's colleges can be met only by mobility of staff throughout the whole educational system.

While the need for mobility among teachers is essential, it is also vitally important that a common field for their education and training be ensured in order to avoid the segregation of particular groups of persons in training. The area training service would again be the appropriate body to undertake the training of teachers for young people's colleges, for thus would mobility be made more practicable.

In examining the supply and training of youth leaders and of the service of teachers in young people's colleges, the McNair Committee has entered practically unexplored fields. The service of youth is a recent development, and, save for a few pioneering experiments, young people's colleges do not at present exist. Nevertheless, the extent of its recommendations leaves little doubt that, within its terms of reference, the Committee has done its work admirably.

RESEARCH ON THE PHOTOGRAPHIC PROCESS

The Theory of the Photographic Process
By Dr. C. E. Kenneth Mees. Pp. xi+1124. (New York: The Macmillan Company, 1942.) 60*s*. net.

DR. C. E. K. MEES, with the help of the Kodak Research Laboratories, has written a book that will be for many years the standard authority on the photographic process. His title describes the book as an account of the theory; but theory is not conceived in a narrow sense as the counterpart of experiment, but rather as including almost everything about photography except its practice. The first chapters deal with the emulsions, what they are made of and how they are prepared; the action of light is then described, the processes that take place in photographic materials under its influence and the large number of theories which has been advanced to account for them. Development and fixation are then discussed, again with the emphasis on the details of changes that take place in emulsions and on attempts to explain them in terms of physics and chemistry. There are further chapters on sensitometry, on the nature of the developed image and on the photographic aspects of sound recording. Finally an account is given of the use of dyestuffs for the production of colour-sensitive film, and for desensitization.

It is remarkable how the advance of physical science often leads to an understanding of the new and unfamiliar long before it can explain phenomena apparently more commonplace. For example, Clerk Maxwell's mathematical genius enabled him to predict the properties of electric waves before they were shown to exist, and as a result the theory and the practice of wireless transmission have advanced side by side, neither proceeding far in advance of the other. The progress of the science of electronics has been similar; there was no great technical advance in the use of cathode rays before their nature was understood, nor in the use of photo-electricity before Einstein's law and the quantum theory gave it a theoretical background. In fact, in the wide field of electrical engineering, the very existence of which could not have been anticipated until the end of the eighteenth century, theory has at times been in advance of practice and seldom far behind it. On the other hand, some of the properties of inorganic matter which have been familiar to mankind for a very long time still somehow resist the attempts of theoretical physics to explain them. Outstanding is the problem of the nature of the liquid phase, and the fact that most solids melt; while solids and gases present no particular mystery and allow their equations of state to be calculated from first principles, this is not true of liquids. More important are perhaps the problems relating to strength of materials, in particular of metals. The enormous body of knowledge on their mechanical properties and on how their hardness and ductility can be influenced has been gained without the help of any theory to show what arrangements of atoms in the materials are responsible for these properties. So great is our ignorance on the theoretical side that it is still possible for experts to argue as to whether an ideally perfect crystal would be very hard or very soft.

Photography, or rather the art of making and processing emulsions, has, in the last ten or twenty years, been emerging from the state in which the

science of mechanical strength is now and gaining a status similar to that of electronics. Dr. C. E. K. Mees' book, therefore, is very welcome at the present time, both as tracing the development of the subject in the days when there was no guiding theory and not much connexion between photographic theory and the rest of physics, and the present position when this is no longer true. The advance in the last few years has been that we now feel that it is 'only to be expected', taking into account what is known from other sources about the behaviour of halide salts, that an emulsion of silver bromide would be light-sensitive and retain a latent image which could be made visible by a reducing agent such as a developer.

The picture given in Dr. Mees' book of the formation of the latent image is now quite definite. Silver halides, in common with many other salts, decompose under the action of light, and metallic silver is formed as little lumps on the surface of the halide grain. After prolonged exposure these can be seen under the microscope, and can be shown by the methods of X-ray spectroscopy to have the same structure as silver in bulk; and much evidence is given to show that the latent image after normal exposure, though too small to be seen, is of the same nature; the number of atoms in each speck may be some tens or hundreds. Particularly interesting is the account given of the researches of Dr. S. E. Sheppard, who showed that in a sensitive emulsion the halide grains must have on the surface a number of specks of silver sulphide. These he called sensitivity specks, and their role is to concentrate the silver atoms formed by the action of the light. They are formed by the presence in suitable gelatines of organic sulphur compounds, due to the predilection of cattle for sulphur-bearing plants, such as mustard—a most fortunate accident. Rabbits do not share this taste, and gelatine from their tissues is inactive, so that, if it is used for the preparation of emulsions, a low sensitivity results.

As regards the mechanism by which light releases silver atoms from the halide crystals, and the way in which these atoms are concentrated in the sensitivity specks, the theory put forward by Dr. Gurney and the present reviewer is in the main accepted and some account is given of the experimental work based upon it which has been carried out by the Kodak Research Laboratories both in Great Britain and the United States. According to this theory, the action of the light is to make the halide grains photoconducting, as a result of which the sensitivity specks acquire a negative charge; they then build up a speck of metal by electrolytic conduction within the halide grain, the positively charged silver ions moving through it towards the negative charge. Particularly interesting experimental work has followed the suggestion that development takes place by the same process, the developer charging the silver specks negatively, and the silver moving towards the latent image through the body of the grain, so that the developed silver is pushed out of the grain in long threads. The electron microscope has enabled very beautiful pictures of the developed image to be taken which suggest that it must be formed in this way; the developed silver grain is not solid, but consists of a tangle of metallic threads between 100 and 1000 A. in diameter, which are held in the space occupied by the original grain simply by the action of the surrounding gelatine. Excellent examples of these photographs, with a magnification of 40,000–50,000, are shown on p. 312 of the book under review.

Interesting and gratifying though it is to see photography gaining the status of an exact science with a theory behind it, it is impossible not to be impressed with the achievements made before this was so, and also perhaps with the number of apparently fortuitous circumstances which have made this advance possible. It is now known that a very large number of metallic salts can be reduced photolytically in suitable circumstances; for example, alkali halides, if illuminated with a wave-length that they absorb and held at a temperature, about 400° C., at which they show ionic conductivity. However, to be useful photographically a metallic salt must absorb light in the visible part of the spectrum, must show ionic conductivity at room temperature, and must on reduction give a metallic residue that does not react with water or oxidize in air. It is fortunate that silver halides and a few other salts have all these properties. That a substance with the properties of gelatine exists seems even more fortunate; it has to be rigid enough when wet to hold the halide grain in position against the somewhat large disruptive forces that must occur during development, and yet be porous enough to allow the large molecules of the developer to pass freely through it. Moreover, it was extremely helpful, for the early production of sensitive emulsions, that it contained organic sulphur compounds capable of attacking the halide grains and forming the sensitivity specks.

It would be wrong to suggest that the science of photographic emulsions does not still contain many interesting problems awaiting solution; perhaps the action of sensitizing dyes is the most outstanding. Dr. Mees' work will be of service in bringing these problems to the notice of physicists and chemists outside the photographic industry, and showing them that the study of emulsions can be interesting and important as much for the information that it gives about the interaction between matter and light as for the influence that it has on the technical applications.

The present reviewer has taken a reviewer's freedom to deal in detail only with those parts of the book which interest him personally; an organic chemist or a sound engineer would naturally have chosen quite different parts, and any review of so comprehensive a work is bound to be somewhat one-sided. In fact, photography now covers a very wide field of science, and this is well brought out in the book.

N. F. MOTT.

MATHEMATICAL PHYSICS

Methoden der mathematischen Physik

Von Prof. R. Courant und Prof. D. Hilbert. (Published and distributed in the Public Interest with the consent of the Alien Property Custodian under License No. A. 82.) Band 1. Zweite verbesserte Auflage. Pp. xv+469. 8 dollars. Band 2. Pp. xiv+549. 8 dollars. (New York: Interscience Publishers, Inc.; London: H. K. Lewis and Co., Ltd., 1931–1937.) 2 vols., 14 dollars.

THESE two volumes are photo-lithoprints of the second edition of Vol. 1, issued in 1930, and Vol. 2, issued in 1937. The first volume contains seven chapters as follows: 1, the algebra of linear transformations and quadratic forms; 2, the development of an arbitrary function in series; 3, the theory of linear integral equations; 4, the basic principles of the calculus of variations; 5, the oscillation and eigenvalue problems of mathematical

physics; 6, application of the calculus of variations to eigenvalue problems; 7, special functions defined by eigenvalue problems.

The original design of writing this work arose from the observation that while mathematics had in the past received inspiration from the close relation which exists between analysis and the intuitive conceptions of physics, the source of this inspiration was tending to run dry. Analysis was becoming more and more an end in itself and the physicist tended more and more to estrange himself from an understanding of the problems and methods of the analyst. No doubt there were faults on both sides; indeed, it is largely true that mathematics tends to outstrip its applications and it is probably too much to ask the physicist to interest himself in those parts of a subject for which he can see no immediate applications. Nevertheless, one cannot remain blind to the fact that this forging ahead on the part of mathematics has served the physicist well, for example, in the development in the present century of the theory of relativity and of quantum theory.

However that may be, Courant saw in this growing estrangement a danger signal to both sciences, and he set about writing a book which should effect a reconciliation by helping the student and preparing the ground for the research worker. This is from every point of view a worthy aim and one which has been ably fulfilled by the presentation in one place of a clear and scholarly account of mathematical methods which appeal to the physicist for their applicability and to the mathematician for their rigour. Moreover, the bringing together of a well-chosen selection from original papers and other published work makes smooth the path of the student to an extent which anyone can appreciate who has had to delve for himself. The usefulness of the work is further enhanced by the attempt to make each chapter substantially independent, thus affording the opportunity of selecting just that topic on which the reader requires orientation.

The second volume is largely independent of the first in that it aims at a systematic treatment of partial differential equations in their relation to mathematical physics. This volume contains seven chapters as follows: 1, preliminary notions; 2, general theory of partial differential equations of the first order; 3, linear differential equations of higher order; 4, differential equations of elliptic type and potential theory; 5, differentials equations of hyperbolic type in two independent variables; 6, differential equations of hyperbolic type in more than two independent variables; 7, solution of boundary and eigenvalue problems by the calculus of variations.

In the first volume many particular problems are considered in which linear partial differentials of higher order are concerned. In the second volume a systematization is attempted with the object of making the subject more approachable.

In mathematical physics it is seldom that the totality of all solutions of a differential equation is required; even the finding of a special class of solutions is not the object. Rather the aim is usually to pick out one particular solution which is to satisfy relations laid down by the problem itself, initial conditions or boundary conditions. In this respect it is important to observe that boundary value problems and partial differential equations of elliptic type belong naturally together, while initial value problems belong to equations of hyperbolic type such as arise in connexion with oscillations and radiation.

From the point of view of mathematics a physical problem is only properly stated when the solution (1) exists, (2) is unique, and (3) depends continuously on the data, the condition of physical determinateness. Throughout this volume the above general considerations are kept clearly before the reader, the emphasis throughout being on the broad connexion of ideas. The last chapter is very interesting, for here the direct method of the modern calculus of variations is applied to establish the existence and uniqueness of the solution of equations of elliptic type. The principle here is to replace the boundary problem by a variation problem in which a function is sought which has the necessary properties of differentiability, and which renders the appropriate variation expression a minimum. It is not assumed that such a minimum exists, but a lower bound d certainly does. There then exists a sequence of functions which are admissible in the variation problem and for which the variation expression tends to d. This sequence of functions, called a minimal sequence, does not necessarily converge, nor, if it does, is the existence of the derivatives of the limit function evident. But it can be shown that it is possible from the minimal sequence to extract a subsequence defining a function which has the required properties of differentiability and which satisfies the differential equation.

L. M. MILNE-THOMSON.

METALLURGY IN EVERYDAY TERMS

Metals in the Service of Man

By Arthur Street and William Alexander. (Pelican Books, A.125.) Pp. 192+20 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1944.) 9*d*. net.

THE purpose of this admirable little work is abundantly fulfilled—that of bringing home to the general reader the importance which metallurgy now occupies in our industrial life. While serving this useful purpose it will, nevertheless, be read with delight by those who already have a wider knowledge of the subject. Although not putting forward a text-book, the authors have succeeded in overcoming the difficulties which are inherent in summarizing so broad a field and this in a manner and with an accuracy of statement to which academical exponents of the subject could take very little exception.

The great merit of the authors of this book is the simplicity of language used in an exposition of matters relating, more particularly, to the character, structure and behaviour in use, of metals and alloys. It has the quality and value of the spoken word rather than the more formal phraseology of the text-book. For this very reason it should be of particular interest to those who are faced with the introduction of this subject to students, and it is to be hoped that the authors may find time and opportunity to demonstrate still further their gifts of exposition for the benefit of those who need some guidance in framing elementary courses of instruction in these important matters. The authors must have derived considerable enjoyment from the compilation of this short account of 'metallurgy without tears', and in making apt use of homely similes with which to press home fundamental principles. Their friendly artist must have shared this enjoyment in devising his quaint and original illustrations, which are diverting and yet convincing.

S. W. SMITH.

Wave Filters

By Dr. L. C. Jackson. (Methuen's Monographs on Physical Subjects.) Pp. vii+107. (London: Methuen and Co., Ltd., 1944.) 4*s.* 6*d.* net.

THE wave filter is the fundamental necessity of all telecommunication work which is not simple telephony. Carrier-telephony and voice-frequency telegraphy, which enable us to pass tens or even hundreds of times the quantity of information the basic systems permit, could not exist without the wave filter. The basic theory dates only from Campbell some thirty years ago. Since then, Zobel, Shea, Starr, Cauer, and many others have derived alternative methods of approach and practical schemes for arriving at economic designs of filters which are to fulfil more exacting conditions of operation.

The incorporation of quartz crystal elements as lowly damped resonant circuits gave a new degree of freedom in design, and permits the union and separation of hundreds of telephonic channels on a single circuit. The attainment of electrical recording for gramophone disks, and the perfection in so far as it was possible in the so-called acoustic reproduction of records, both resulted from applying what had been solved for electrical circuits to mechanisms intended to operate over a wide range of frequency. Acoustic filters for attenuating specific frequency-bands also followed along the same lines.

The difficulty for a student approaching the subject is either the mass of information contained in the standard text-books, or the skeleton data provided in handbooks or in single chapters in texts on wider subjects of electrical communication or radio. The present author tries to meet the student by outlining the above-mentioned subjects, with just as much theory as will give the student confidence in using any of the great mass of formulæ available in the actual production of filters. The author does not treat at any length the usage of filters in practice, for example, the impedance conditions which are imposed when filters are used in parallel, or any special conditions imposed by the association of filters with modulators. In the space available in these excellent monographs, the author has presented the subject in concise and readable terms, and if there is nothing original, the assistance which he affords the student of filters is ample justification.

L. E. C. Hughes.

The Subject Index to Periodicals, 1942

Issued by the Library Association. Pp. x+175. (London: Library Association, 1944.) 77*s.* net.

THE seventeenth volume of "The Subject Index to Periodicals" covers the year 1942 and presents no new features. It is compiled on the plan of the 'dictionary catalogue', articles being entered under specific headings in alphabetical order. The principle is not carried to inconvenient extremes; for example, articles on the individual vitamins are collected under vitamins and are not dispersed under their respective names, while cross-references play an important part in linking up related subjects. Explanatory matter in square brackets is often added where the titles do not sufficiently indicate the subject. The preparation of the "Index", as formerly, has largely depended on the vast resources of the British Museum, while from September 1940 until October 1943 the editor and his staff were accommodated in the National Library of Wales, Aberystwyth. With some important exceptions, including, for example, NATURE, *Engineering*, the *British Medical Journal*, periodicals covered by the *Agricultural Index*, *Engineering Abstracts*, *Index Medicus*, *Journal of the Royal Society of Arts*, *Petroleum Institute Abstracts*, *Photographic Abstracts*, *Science Abstracts*, *Journal of the Textile Institute* and the *Royal Meteorological Society Bibliographies* are not indexed; but scientific workers will find the "Index" a useful means of picking up signed articles on scientific subjects in leading general periodicals, as well as in tracing authoritative articles on a wide range of social and economic problems, education, reconstruction, etc., in the leading reviews and periodicals.

Reports of the Progress of Applied Chemistry

Issued by the Society of Chemical Industry. Vol. 27, 1942. Pp. 546. (London: Society of Chemical Industry, 1943.)

THE progress of applied chemistry, as illustrated by publication during 1942, is summarized by this report, which conforms to the established pattern. The following fields are reviewed: general, plant and machinery; fuel; gas, destructive distillation, tar and tar products; mineral oils; intermediates and colouring matters; fibres, textiles and cellulose; pulp and paper; acids, alkalis, salts, etc.; glass; ceramics, refractories and cements; iron and steel; non-ferrous metals; electrochemical and electrometallurgical industries; fats, fatty oils and detergents; plastics; resins, drying oils, varnishes and paints; rubber; leather; soils and fertilizers; sugars and starches; the fermentation industries; foods; fine chemicals and medicinal substances; photographic materials and processes; sanitation and water purification.

Great activity in the direction of synthetic chemical production by the petroleum industry is noted. Magnesium at 1*s.* per lb. is, if measured by volume, cheaper than aluminium at 7½*d.* per lb., and its use in aircraft construction is substantial. With reference to the potentialities of the electrochemical and electrometallurgical industries, it is estimated that in the British Empire some 107 million horse-power of water-power is available, and that of this only about 6 per cent has yet been developed. Progress in the soilless culture of plants is briefly summarized, and this technique of commercial food production is considered to possess every prospect of success. The blackening of potatoes is attributed to hydrolysis of an iron complex which is said to result from growth in soil deficient in potassium but rich in nitrogen.

Health and Hygiene

A Comprehensive Study of Disease Prevention and Health Promotion. By Lloyd Ackerman. Pp. xii+895. (Lancaster, Pa.: Jaques Cattell Press, 1943.) 5 dollars.

THE scope of this book is very wide. In providing a guide to the layman for the proper regulation of his mental and physical life, the author runs riot from physiology to psychology with nothing missed in between. It is doubtful if anyone could ever plough his way entirely through to the end, although this would certainly be an enlightening task. As a book of reference, a modern 'home doctor', this one has much to recommend it. The advice is always sound and common sense, and the explanations are clear and simple. Teachers, medical men, or lecturers preparing talks on any branch of hygiene for youths or adults would find here much useful and relevant information.

FUNGI AND MODERN AFFAIRS*

By DR. J. RAMSBOTTOM, O.B.E.
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IT is a little surprising that fungi should have received so little consideration from academic botanists, for they are more numerous in species and in individuals than is the rest of the plant kingdom. They are classed in the vegetable kingdom, for with the old divisions, plants, animals and minerals, there is nowhere else for them. But they are not plants in the ordinary sense of the word as they have no chlorophyll and there is no evidence that they were derived from organisms so provided. A great amount of research has been carried out during the last half-century to ascertain the precise methods by which green plants build up carbohydrates; but comparatively little attention has been paid to the manifold and diverse physiological processes by which fungi obtain their nutriment. In their search for food, fungi play many parts in the drama of Nature and in modern affairs.

To many the word fungus conveys the idea of something mysterious or foreboding: to others mushrooms and toadstools. J. Bauhin appeared to combine the two ideas when he derived the word from *funus* (funeral) and *ago* (to put in motion), a derivation which John Ray considered appropriate even if possibly not correct.

What is a mushroom? The term is often loosely applied to those larger fungi which are edible, it being assumed that only the field mushroom and possibly one or more of its near allies are safe to eat; the rest, assumed to be poisonous, are grouped together as toadstools. But the assumption puts the facts the wrong way round, for there are less than a dozen species which are in any way poisonous; the vast majority are harmless. It would be illogical to speak of even the three hundred or more edible species as mushrooms and the others as toadstools; it seems preferable to call all agarics 'toadstools', restricting 'mushroom' for the species of the genus Psalliota: in this way, moreover, some of our insular and peculiar prejudice against them might be toned down.

Toadstools have been eaten from the earliest times. There is no reference to them in the Bible, but classical writers leave us in no doubt that fungi were well known as peculiar organisms of strange growth, so well known indeed that they were the subject of puns. Accidents sometimes occurred and, as these seem to be specially noted, it has been assumed by some that the use of fungi as food was regarded as too dangerous to be indulged in. What is more probable was that fungi were a common food, but accidents were especially noted because of the difficulty of distinguishing between wholesome and poisonous species. It was comparatively simple to get a knowledge of what plants and fruits are safe to eat for they are easy to recognize again, they are lasting, and. even if annual, they are constant in their time and place. Consequently they all had names. Fungi, on the other hand, are difficult to describe, and the fleshy ones are of irregular occurrence and of short duration. For this reason we find rules for distinguishing between edible and poisonous species rather than names and descriptions. Many of these rules are still current—'peeling', and the non-blackening of a silver spoon being the most widely believed, and this throughout Europe, possibly owing to them being repeated in the old herbals. All are utterly worthless, even dangerous. There is only one real test. Many have tried it, and as there are numerous records of experiments which ended in disaster, we have a mass of evidence which relieves us of the necessity of personal trial.

It is only in Great Britain that toadstools are rejected as food. Eighty years ago, five or six species were on sale in Covent Garden Market; but later only the mushroom, wild or cultivated, was displayed. It is hard to account for the British prejudice against them. It has been suggested that it is because of our high standard of living, or alternatively because of the absence of well-wooded country: but these do not explain the fear most people have of them.

In Continental countries with hard and long winters, fungi are dried and pickled and form a staple food while the frosts last; they also serve in place of meat during religious fasts. In all Continental countries fungi are sold in the markets, and many towns have special fungus markets. Usually there is some sort of control, and the number of species allowed to be sold varies from half a dozen to more than three hundred.

Though in Great Britain the chief use of toadstools is as appetizing additions to other dishes, they have a certain food value. There is need of more precise information on this, for many of the old analyses led to extravagant claims. Darwin recorded that the Terra del Fuegians eat no vegetable food except Cyttaria and a few berries, whereas Lettow-Vorbeck recounts that when, during the East African campaign of the War of 1914–18 the difficulties with food had reached a most embarrassing stage, the German troops were able to carry on owing to finding enormous quantities of edible fungi which were to them as manna was to the children of Israel.

There are a number of species which have always had a good reputation as edible, which moreover are easy to identify and which cannot readily be confused with any poisonous forms. For those not making a special study of the subject, it is advisable to learn to recognize some of these, rather than to experiment with others about which all that is known is that they are not among those regarded as poisonous.

The most deadly poisonous species is *Amanita phalloides* (including the two white varieties or closely allied species *A. verna* and *A. virosa*). It is responsible for practically all the recorded deaths from fungus poisoning and the death-rate is more than 50 per cent —indeed, it has been put as high as 90 per cent. There is a characteristic period of quiescence after the fungus is eaten, on an average twelve hours, though it may be as long as forty. Death may occur on the first day, but is usually on the third or fourth day. There are apparently four poisons contained in this species: Amanita hæmolysin (phallin), a glucoside readily destroyed by heat and digestive juices; Amanita toxin with a complicated and indefinite chemical structure; and according to the work of F. Lynen and U. Wieland (1937), phalloidin, which is quickly acting though destroyed by heat, and an additional slower-acting toxin. Death through eating the cooked fungus is apparently due to the heat-resistant Amanita toxin. Cures have been reported by the use of a 'sérum antiphalloidien' prepared at the Pasteur Institute; by intravenous injection with 20 per cent glucose solution; by intravenous injection with 10 per cent sodium chloride solution; by

* Substance of three lectures at the Royal Institution, delivered on February 15, 22 and 29.

administering the finely chopped up stomachs of three rabbits and the brains of seven.

Amanita mappa, formerly considered as very poisonous, is edible but not worth eating. *Amanita muscaria*, which contains muscarin, mycetoatropin and choline, does not cause death in healthy people. The symptoms of poisoning usually simulate alcoholic intoxication, though there are occasionally gastro-intestinal disturbances. *Amanita pantherina* produces similar symptoms.

The remaining species which are in any way dangerous, raw or cooked, are *Lepiota helveola, Entoloma lividum, Inocybe Patouillardi, Boletus Satanas* and *Gyromitra esculenta*, though some other species are very indigestible and consequently may cause disturbance.

Claviceps purpurea (ergot) is a poisonous fungus of another group. The two different types of ergotism, the convulsive and the gangrenous, are now well known. Five alkaloids have been isolated from ergot: ergotinine, ergotoxine, ergotamine, ergotaminine and ergometrine. As its name suggests, ergosterol was first extracted from ergot; histamine also. The use of ergot in childbirth is mentioned by Lonicer in 1582 in the first record of the fungus. At present ergot is the only fungus which figures in the British Pharmacopœia.

Fungi, being without chlorophyll, have a physiology which in many ways is more animal-like than plant-like. Obviously there are two main sources of food, living organisms and dead organic material. Fungi make use of both—they parasitize all kinds of living organisms, and there is no sort of organic matter not liable to attack. But though they are responsible for the greater part of plant diseases and they cause destruction to stored products of every kind, the changes they bring about are not all to our detriment as living organisms. They act as scavengers reducing dead material into substances available for plant life, and moreover prevent the cluttering up of the earth's surface. The action of soil fungi on plant material was overlooked when untreated jute sandbags were filled with sand and even ordinary earth at the outbreak of the present War. The modern compost heap is a contrivance to bring about the breaking down of similar cellulose substances.

Forest trees are subject to attack by larger fungi as well as by microscopic forms. Timber from such trees is unsuitable for most purposes and, moreover, if not properly seasoned, may continue to rot. Fallen logs and stumps have a characteristic flora, and several of the species occur on wooden fences, gate-posts and similar structures; *Lentinus lepideus*, for example, attacks wood pavement blocks, telegraph poles and railway sleepers.

If wood is to be preserved, it must be kept dry or treated with some fungicide. The chief agent of destruction of structural timber is *Merulius lacrymans*, the dry-rot fungus: there are other fungi causing dry rot, but the damage they produce is trivial. If timber is properly seasoned and then kept dry by ventilation so that it never contains as much as 20 per cent moisture, the fungus will not attack it; otherwise damage is almost certain. At the present time, the amount of dry rot in London calls for serious attention. It is easy to understand how houses which have been severely bombed are liable to have their timber affected, but blast has cracked water-pipes with a consequent seepage of water through the walls; leaves and other rubbish have caused overflows which run down the walls; shelters have been constructed so that ventilation and even water-courses have been interfered with; ventilation bricks have been stopped up to prevent entrance of gas; or sand-bags which became rain-sodden propped up against walls, often over air-bricks; houses left unattended, with no heat and leaky roofs; water-tanks and pipes bursting, water-taps left running in requisitioned buildings—all have played their part in bringing about a good deal of unnecessary waste. Furthermore, there is need for some scientific control over new housing plans or we shall have a repetition of the troubles which affected whole building estates after the War of 1914–18.

In addition to causing diseases of trees, microscopic fungi cause disease not only of crops but also of wild plants. The most striking point about the flora of bombed sites is the rapid appearance of special fungus parasites, as for example *Bremia Lactucæ* on groundsel. The idea that disease is a result of civilization is very attractive to some minds—but is entirely false.

Fungi are the main causal agents of disease in plants. The losses in different crops vary normally from 2 to 50 per cent: figures for the U.S.A. for wheat, oats and barley in 1935 due to rust alone were estimated at 277, 185 and 53 million bushels respectively. There are many ways of combating fungus attacks, the most obvious being the use of fungicides. Much depends upon having a thorough knowledge of the life-history of the parasite as well as that of the host plant, for then the fungus can be tackled at its most vulnerable stage.

Some varieties or races of plants are immune to the strain of fungus parasite common in the neighbourhood, and much work has been done in the attempt to breed immune races. But it is frequently overlooked that there is often as much variation in the parasite as in the host. Thus the problem of producing a wheat immune to black stem rust theoretically necessitates the building up of a resistance to 177 physiological races, though, practically, only the local strains present in any one area need be considered.

Less than a century ago, when the parasitic nature of many diseases was beginning to be suspected, fungi were thought to be responsible for many human affections. This was a consequence of Schoenlein's discovery in 1839 of the fungus causing favus, which was immediately followed by Lagenbeck's describing the fungus of thrush, and soon afterwards by Gruby's description of ringworm. With the gradual recognition of the predominance of bacterial diseases and the abundant problems they presented, mycology, except for the obvious dermatophytosis and actinomycosis, has not received the attention due to it, especially in Great Britain. Many of the ring-worm group are able to live parasitically on domestic animals; some are known to live saprophytically on organic debris and others have been reported as capable of infecting living plants. Athletes' toe (Trichophyton spp., Epidermophyton) has become increasingly common in Great Britain during the past few years and is prevalent in certain sections of the Fighting Services. But there are many less obvious diseases which have been studied principally in France and America. That they exist elsewhere is shown by the recent recognition of histoplasmosis (*Histoplasma capsulatum*) in Great Britain. The symptoms of this disease are protean; they may simulate kala azar or pulmonary tuberculosis—and

the prognosis is bad. A recent discovery by C. W. Emmons that small desert rodents constitute an important natural reservoir of *Coccidioides immitis*, the cause of coccidioidal granuloma, is of importance. This disease has been known for about half a century in North and South America and was thought to be soil-borne. The Medical Research Council has recently appointed a committee to report on the situation of medical mycology in Great Britain.

Animals other than those domesticated are also liable to fungal disease. Insects particularly are affected, whole groups of fungi being entomogenous; as, for example, the Laboulbeniales with about 120 genera and 1,500 species, so well monographed by Thaxter. Moreover, it has been shown recently by C. Dreschler that there are a number of species, Entomophthoraceæ and Hyphomycetes, which parasitize nematodes, amœbæ and other small soil inhabitants.

The extent of the damage by fungi to stored products of all kinds is only gradually being realized. The losses in textiles have received most attention and the investigations of the conditions in which cotton and wool become 'mildewed' are influencing the practices of manufacture. The methods of preserving foodstuffs—sterilization, canning, pickling and so on—are chiefly to prevent mould attack, though they also protect them from bacterial contamination.

The outward and visible sign of specific differences in fungi is morphological as in green plants and animals, but this should not mask the fact that a given species growing under definite conditions always acts in the same way and brings about the same results. Can we so harness any species that it will produce results useful to us? What has Nature herself done in this direction?

Armillaria mellea is a common toadstool which causes a good deal of disease in trees but is also able to live saprophytically. It spreads by means of rhizomorphs, strands of compacted mycelium which look somewhat like flattened, branched and anastomosing, black leather bootlaces. If these encounter potato tubers, they reduce them to mush in two or three days. On the other hand, if the rhizomorphs meet the tubers of the Japanese saprophytic orchid *Gastrodia elata*, they penetrate for only a certain distance and are then held in check. An uninfected tuber sends out a dropper and the process is repeated each year until a tuber is formed which is too small to grow. An infected tuber, however, sends out a dropper which produces an inflorescence the following year. It is obvious that the orchid obtains nutriment from the rhizomorphs, which presumably act as conducting strands. It may be that in some such reversal of parasitism we have a clue to the origin of the more typical mycorrhiza or fungus-root. Orchids are the classical example of obligate symbiosis, the seeds not normally germinating unless infected by the fungus present in certain cells of the roots. In modern methods of commercial orchid growing, either the seeds are infected artificially with the appropriate fungus, or its action is replaced by sowing sterilized seeds on a medium containing sugar.

Forest trees have a layer of fungal hyphæ surrounding many of the absorbing rootlets, the fungi concerned being mainly of the toadstool type. Many perennial plants also have mycorrhizas, but it is not yet certain which fungi are concerned: the usual appearance is suggestive of Phycomycetes. Similar associations with fungi occur throughout the plant kingdom.

The association of fungus and alga has resulted in the large homogeneous class Lichens.

Many insects have internal yeasts: indeed, these are supposed to have played a definite part in the evolution of some insect groups. A more obvious harnessing is that of the leaf-cutting ants of South America which, as first described by Bates and amply confirmed since, cultivate fungi of the toadstool type in their fungus gardens. An association in which the fungus seems to be less in subjection is that of bacteria and yeast which are active in various fermented drinks—Mexican tibi, koumiss, kephir, leben, tea cider, ginger-beer plant—some fermenting sugary liquids, others milk.

In addition to these combined masses, which are usually in the form of grains, man in his early history noted that fruit juices or other sugary fluids underwent a change if left for some time: honey-comb washings became mead, grape juice became wine. These much appreciated changes, the work of yeasts, were not to be left to blind chance, and in the course of centuries the conditions controlling the changes and finally the reason for them became known. Nowadays distillers, brewers, many wine growers and cider manufacturers no longer rely on some general supply or on casual wild yeasts, but maintain pure cultures of special strains of the appropriate species which have proved to give the best results in the conditions of production. Here we have the breaking down of organic matter by fungi to give a desired result. It must be stressed, however, that a fungus acts only in a certain way in definite circumstances.

Pasteur's classical researches on fermentation were a direct outcome of the misfortunes that befell France after the war of 1870. It is surprising how often an odd fact he mentioned more or less incidentally has been followed up by later investigations. Thus during the War of 1914–18, German scientific men turned their attention to Pasteur's observations that proteins could be synthesized by yeasts from inorganic nitrogen, including ammonium salts. The fact that yeast, including brewers' yeast, contains a high percentage of protein had long been known and attempts were made to utilize the surplus quantities from brewers until the production of beer was cut by 60 per cent. In 1915, Hayduck announced that he had discovered what he called 'mineral yeast', as a contaminant at a pressed yeast factory. This yeast, which is non-sporing and was afterwards called *Torula utilis*, gave much better yields of protein than did other yeasts and, moreover, produced little alcohol. A yeast product was put on the market, but large-scale production apparently could not be carried on because of lack of sugar.

With the outbreak of the present War, the possibility of a shortage of protein had to be faced, and the problem was allotted to A. C. Thaysen and his colleagues at the Chemical Research Laboratory. Eventually they decided that *Torula* (*Torulopsis*) *utilis* was most likely to prove satisfactory. As the situation developed, it was realized that the post-war feeding of ravaged Europe would be one of the major problems, and that for some time vitamin B deficiency would be an additional danger. An analysis of dried *Torula utilis* showed that as well as 45–50 per cent of a protein only slightly less nutritive than a good animal protein, this 'food yeast' contains the whole known range of water-soluble B vitamins. Further,

it mixes readily with water and with milk and can be used in all sorts of ways. Large-scale manufacture is to be carried out in Jamaica where molasses is abundant—200 gm. of molasses give 50–60 gm. of food yeast. The Colonial Development Fund has granted £150,000 for the erection of the plant and it is estimated that 'food yeast' can be marketed at 6*d*. per lb. Many other parts of the Empire are considering erecting plants for the benefit of the local population. It is understood that in Germany the yeast is again being used with hydrolysed wood as the source of sugar.

At Teddington, a strain of *T. utilis* was developed which will grow better at tropical temperatures than would the normal form. It gives a quicker yield and has less variability in size. Later, a giant strain (v. *major*) was produced by acting on the cells with camphor: the biochemical activities are identical, the variety is stable, its cells are more readily separable and its generative time is considerably less.

Another observation by Pasteur was that in ordinary yeast fermentation a small percentage of glycerine is always produced. During the War of 1914–18, the Germans were short of glycerol for making explosives. Neuberg, in 1911, had begun to publish his studies on the stages leading to alcohol formation by yeasts. When experimenting on aldehyde fixation with sodium sulphite, there was a large increase in the percentage of glycerol. Connstein and Lüdecke successfully applied this to large-scale production: many will remember the wild guesses that were made at the time concerning the source of the enemy's glycerine. They produced 1,000 tons a month by the method, the average yield being 20–25 per cent of the sugar used, and in addition large quantities of alcohol and acetaldehyde were obtained as by-products. It has been said that it enabled the Germans to carry on the war for another twelve months. The Americans, hearing that glycerine was being produced by yeasts, succeeded in devising a couple of similar processes. H. Raistrick and his colleagues, after 1918, used a modified sulphite process at Nobel's factory at Ardeer and increased the yields of glycerine in the fermentation liquor to 35–40 per cent of the weight of sugar fermented. Subsequent improvements in the methods of recovery of glycerine from the fermentation liquors have reduced the cost of fermentation glycerine to a figure comparable with that of soap lye glycerine.

One of Pasteur's statements, "We are convinced that a day will come when moulds will be utilised in certain industrial operations, on account of their power of destroying organic matter"*, in spite of its definiteness, was generally disregarded. However, his favourite pupil van Tieghem established the importance of moulds in the biochemical field. He investigated the method of production of gallic acid from heaps of vegetable matter containing tannin—gall nuts, sumach, tea, etc—watered and allowed to go mouldy. He showed in 1867 that the mould principally concerned is *Aspergillus niger*. The present-day method of production is to inoculate clear tannin extract with this fungus.

It was not until 1893 that the first real advance was made, when Wehmer described the production of citric acid by two species of Penicillium (Citromyces) grown in nutrient sucrose solutions containing calcium carbonate. It has been found that a number of moulds produce citric acid, but the one used on a commercial scale is *Aspergillus niger*. In 1922, Italy produced about 90 per cent of the world's supply of calcium citrate from citrous juices, but within eight years the export had practically stopped because of the commercial production by moulds—10,000,000 lb. annually in the U.S.A. alone. There is now an International Citric Acid Agreement.

The process is a surface fermentation of a nutrient sucrose solution, with a comparatively large amount of mineral acid which prevents the growth of bacteria and most moulds. The solution is seeded with spores of *Aspergillus niger*, and as these germinate the surface becomes covered with a frail pellicle which rapidly develops and, by the end of the fermentation (8–12 days), becomes a fairly thick and deeply intricately folded mat but still quite white. Most of the sugar has by then disappeared from the solution, its place being taken by citric acid practically unaccompanied by other organic acids: the solution is much more acid than good lemon juice. Some of the sugar, however, is converted into fungus starch and some into dextrin. The standard way to recover the citric acid from the fermented liquor is to add milk of lime and heat nearly to boiling point, then filter off the difficultly soluble calcium citrate and wash with hot water.

Another process in which *Aspergillus niger* is used is the production of gluconic acid, the calcium salt of which is of importance in pharmacy. Here the best results are obtained from well-aerated submerged growth, which is most economically accomplished by using rotatory drums.

Moulds are able to build up their normal cell constituents from an amazingly large and varied series of carbon compounds. Moreover, as seen with *Aspergillus niger*, the same species of mould, when growing in slightly different conditions, can produce different substances. Citric acid, oxalic acid, gluconic acid, ethyl alcohol and mannitol, which may be regarded as the breakdown products of the original sugars, are formed by many species.

There are, however, many substances which are built up by mould growth, and for the most part these are highly specific products of a single species, or of a few related species. The chief worker in this field has been Raistrick, who, following on his work on glycerol production, has been engaged with numerous collaborators in investigating the general biochemistry of moulds. The scheme followed has been to use glucose as the sole source of carbon in a synthetic culture medium—usually Czapek-Dox medium. In this long-continued and productive research, about a hundred substances previously unknown to science have been prepared and many of them synthesized. It may well be that some of these will be found useful in some way or other, but their present interest is chiefly in giving us a picture of what happens inside the cell. Mould pigments, simple quinones, polyhydroxy-anthraquinones and hydroxyxanthones, simple benzene compounds, chlorine-containing metabolic products, derivatives of tetronic acid (stimulants of bacterial growth), antibacterial and antifungal substances are included in the products*. It is a matter of phylogenetic interest that the lichen acid physcion (parietin) is formed by sixteen species or strains in the *Aspergillus glaucus* series.

To understand the magnitude of work of this kind one has to take into consideration that in a given

* "Studies on Fermentation". By L. Pasteur. English translation, 1879, p. 261. I am indebted to Dr. J. Yuill for directing my attention to this.

* A wide range of these special chemical compounds was exhibited.

species there are strains some of which are more active, some less; further, that the results differ according to the chemical constitution of the medium and the physical conditions of growth.

Ever since fungi and bacteria were grown on artificial media, it has been observed that in mixed cultures one organism may have no apparent effect on the growth of the other, or it may influence it either favourably or unfavourably. This favourable effect (synergism) may be considered as an aspect of symbiosis; the unfavourable (antagonism) as an aspect of the struggle for existence.

Antagonism is gradually becoming recognized as a factor in plant disease. The fungi which abound in the soil include some species which are able to become parasites and cause destructive root rots. Chemical and physical conditions of the soil determine the amount of a given species, but they also act on the other fungi present, one or more of which may have an antagonistic reaction towards the parasite. Thus the mould *Trichoderma viride*, common in the soil, has an antagonistic effect on the growth of the tree parasite *Armillaria mellea*.

The phenomenon of antagonism has been brought strikingly to public notice following an observation by A. Fleming in 1928. When studying the growth of Staphylococcus on solid media in Petri dishes, he noticed that the colonies underwent lysis in a zone surrounding a growth of Penicillium which contaminated one of his cultures. He grew the Penicillium in broth culture, and found that the filtrate was some two or three times as effective as pure carbolic acid in stopping the growth of Staphylococcus.

For convenience the name 'penicillin' was used in place of the rather cumbersome phrase 'mould-broth filtrate'. Fleming showed that penicillin had a specific action on certain bacteria (Staphylococcus, Streptococcus, Pneumococcus, Gonococcus and the diphtheria bacillus), but that others (*B. coli* and *B. influenzæ*) were not affected. The first practical application of penicillin was the isolation of the insensitive Pfeiffer's bacillus, which in the respiratory tract is usually associated with organisms highly sensitive to penicillin. But Fleming also stated that penicillin had no poisonous effect and that "it may be an efficient antiseptic for application to, or injection with, areas infected with penicillin-sensitive microbes". In 1931, he prophesied that "it is quite likely that it, or a chemical of a similar nature, will be used in the treatment of septic wounds". In the following year Raistrick and his collaborators grew the Penicillium (which Thom identified as *P. notatum*) in a synthetic medium consisting solely of glucose and inorganic salts, and defined the optimum conditions of growth. They acidified the medium slightly, extracted with ether, and on removal of the ether obtained the anti-bacterial substance in a crude form and to it restricted the name penicillin. It was found to be extremely labile. A very definite step had been taken* and sulphonamides were not yet discovered. It remained for H. W. Florey and his collaborators to reveal the outstanding therapeutic properties of penicillin. Florey worked first with lysozyme, another of Fleming's discoveries, and in the search for other anti-bacterial substances produced by micro-organisms, E. Chain and Florey turned their attention to penicillin. A culture of Fleming's fungus was obtained and the penicillin was extracted with amyl acetate. Shaking out the amyl acetate with a buffer solution and evaporating the buffer solution gave a substance which was at first thought to be pure penicillin because it proved to be so active. The results of the clinical trials published in 1940 showed that it possesses unique therapeutic properties which, moreover, because of its non-toxicity, make it of outstanding value in the treatment of war wounds. But the penicillin used in these chemical experiments was only about 1 per cent pure. Several workers here and in the U.S.A. are engaged on research in purifying penicillin; a crystalline sodium salt has been obtained which is substantially pure and is a hundred times more active than the first extractions. It is capable of inhibiting the growth of certain bacteria at a dilution of about 1 : 50,000,000. Penicillin is a complex acid of which the exact structure is not yet known.

Until recently, all the *Penicillin notatum* used, both in the laboratory and in large-scale manufacture, was from Fleming's original isolation. It was indeed a strange chance which led to the contamination of a laboratory culture by an apparently uncommon mould (originally described from decaying hyssop in Norway); and that the laboratory should be that of one who was curious in antibiotic phenomena and who, convinced of the value of his discovery, kept not only the original plate but also maintained the mould in culture. Further, it was fortunate that the original Oxford isolation of crude penicillin contained little if any toxic substances, with the result that Florey and the Oxford team were so soon able to announce almost undreamed-of achievements. This general freedom from association with harmful products incidentally has also characterized 'home-grown cultures' of penicillin.

Penicillin is the most active bacteriostatic substance so far known; but the difficulty of obtaining sufficient quantities and its unstable quality have led to the search for similar mould products, and has also stimulated general research. There are many such products known, but few are sufficiently non-toxic for use. Flavicin from *Aspergillus flavus* and gigantic acid from *A. giganteus* are most similar to penicillin in their chemical and biological properties.

Raistrick and his colleagues have tested many of the compounds they had isolated and all new substances which were obtained. The product of the fermentation of *Penicillium patulum* (originally isolated from sheep dung in France) was considered promising and was sent to W. E. Gye, who is studying the effects of various substances on cancer cells. As he was suffering from a cold, he used it on himself with most satisfactory results. Extended trials show that it is able to cure a promising number of cases of one form of the 'common cold'. It has since been shown that patulin is identical with clavacin and clavatin obtained from *Aspergillus clavatus*, and claviformin, from *Penicillium claviforme* and *Aspergillus giganteus*. It is not surprising that the same chemical substance should be formed by several fungi —indeed, this is what one would expect. What is of greater interest is that it is also produced by *Penicillium expansum*. Van Luijk in 1938, studying the diseases of grasses caused by species of Pythium, found a difference in plants grown in sterilized and non-sterilized soil. He isolated a number of fungi

* "Another point which shows what practical results may be expected from such research is that penicillin, a metabolism product of *Penicillium notatum* is non-irritant and non-toxic, but has a strong though differential antibacterial power." Presidential Address to Section K of the British Association, Ann. Rept. Brit. Assoc., 1936, p. 215.

from the soil and from the air and tested their influence on the growth of Pythium. He found that *Penicillium expansum* was the most markedly antibiotic, and adopting Fleming's procedure, obtained sterilized filtrates: these inhibited the growth of *Pythium debaryanum* at dilutions of 1 : 1,280. He did not isolate the antifungal substance, which Anslow, Raistrick and G. Smith (1943) have shown to be patulin. When the fungus was added to garden soil infected with Pythium, seedlings remained healthy instead of damping off.

Here we seem to have a linking up of different lines of research in such a way that we may expect considerable progress. The recognition of the chemical constitution of a substance produced by a common soil fungus which suppresses the growth of a plant pathogen suggests that greater precision may soon be given to many of the older observations on fungal antagonism of various kinds. Incidentally, it may also have some bearing on the question of natural compost versus chemical fertilizers. There is a difficulty in establishing the growth of antagonistic organisms in the soil; this can be done only by modifying the conditions, and an obvious way to do this is to add manure or compost which favour fungal growth. That the matter is not quite so simple as it appears at first sight, however, may be judged from the fact that Barnum in 1924 showed that the filtrate of cultures of *Penicillium expansum* caused wilting in certain herbaceous plants placed in it.

No more than mention can be made of the production by fungi of fats, ethyl alcohol, lactic acid, vitamins, and enzymes, or of the immense fermentation industries of the Orient.

PLASTICS AND ELECTRICAL TECHNOLOGY

PLASTICS and electrical technology are close allies on the industrial front, with many points of contact, and in recent years meetings have been arranged at which members of the two professions can exchange views and comments on recent developments of common interest. The latest meeting of this kind, arranged by the Plastics Group of the Society of Chemical Industry, was held at the Institution of Electrical Engineers on April 14, when the topics selected were the electrical properties of the newer thermoplastics, radio-frequency heating, and 'tracking'.

In opening the discussion, Mr. H. A. Nancarrow pointed out that in the pure hydrocarbon thermoplastics, poly-ethylene, poly-*iso*butylene and polystyrene, we have arrived at the almost perfect dielectric, in the sense that their power factors are almost vanishingly small, over the entire range of frequency and temperature encountered in electrical practice. In these materials we have the excellent qualities of pure paraffin wax associated with a wide range of mechanical qualities from great flexibility to brittleness. The power factors of the pure materials are, generally speaking, of the order of 0·0003. Much higher values are sometimes quoted, but they are usually due to impurities; either plasticizers added to facilitate extrusion or moulding of the material, or oxidation products, produced when the material has been overheated in air. These materials have made possible many developments in electrical communication at the highest frequencies, where even the smallest power factor, or power loss per cycle, may be very significant. At lower frequencies where higher power factors can be tolerated, thermoplastics like poly-vinyl chloride, which is doing valuable service as a rubber substitute in power cables, and polymethyl methacrylate, well known as 'Perspex', are being widely used. The power factors of these materials are of great scientific interest. They show the characteristic of all polar materials—a high maximum value at a particular frequency or periodic time corresponding with the relaxation time of the molecule. The work of Fuoss and other workers in America on the effect of plasticizers on this molecular relaxation was reviewed, but the discussion showed that though the spade work is progressing well, it has not yet reached the stage where important generalizations are possible.

In opening the discussion on the second topic, Dr. L. Hartshorn remarked that it has recently received a great deal of publicity under such very questionable terms as 'radiotronic' heating and 'heatronic' processes. These newly coined terms seem to be entirely unnecessary. The term 'radio-frequency heating' is satisfactory, but it includes eddy-current heating of metals at radio-frequencies, as well as that of plastics and other insulating materials by the process under discussion, which Dr. Hartshorn suggested should be called 'dielectric heating'. The meeting appeared to be prepared to accept the suggestion. The basic facts have long been known. Any solid or liquid insulating material placed near a conductor which is maintained at a high alternating voltage of high frequency becomes more or less hot. The heat is generated throughout the whole mass of the material, the rate of conversion of electrical energy into heat in any element of volume being proportional to the square of the electric field-strength in that element. The basic experimental facts were forced on the attention of radio engineers in the earliest days of high-power wireless transmitters: insulating supports frequently became so hot as to catch fire, and much research has been needed to discover materials like the pure hydrocarbons discussed by Mr. Nancarrow in which the development of heat is as small as possible, and those which will resist better the action of the heat that is developed. The new ceramic materials are of this class.

The idea of utilizing this generation of heat for industrial purposes seems to have originated in various quarters about fifteen years ago, though it has only quite recently been put into practice on any extensive scale. American patent literature from 1930 onwards describes various schemes for using dielectric heating for sterilizing milk and other foods, killing pests in plant bulbs, drying artificial sponges and tobacco, cementing plywood and safety glass, and leather soles on to shoes, and so on. At first sight it seems curious that the method is still a novelty in industry; no doubt economic factors as well as the technical difficulties have played their part here.

The importance of the process lies in the fact that it makes possible the rapid and uniform heating of thermal non-conductors of any thickness. In a large American plant stacks of plywood 1 ft. thick are said to be heated through a temperature range of 160° F. in five minutes, this rise of temperature being required for the setting of the urea-formaldehyde glues employed in the making of the plywood. The method has also proved valuable in the plastics

industry for the heating of moulding materials as a preliminary to moulding. The uniformly heated material flows better into the mould and gives a more uniform moulding than material heated by a contact method, while the rapid heating reduces the time required for the complete moulding process.

An attractive feature of the process is that it makes possible the selective heating of a mixture or composite structure. Thus in fields of a given strength and frequency, the rates of generation of heat in different materials are proportional to the product of their dielectric constant and power factor. The power factor of plate-glass is very small and almost invariable over the whole range of radio frequencies ; that of cellulose acetate rises to a high value at a frequency of the order of 10 Mc./s. Thus if alternate layers of plate-glass and cellulose acetate are placed in a high-frequency electric field, the plastic will generate sufficient heat to be brought to the softening point while little heat is generated in the glass. The prospect of facilitating the manufacture of safety glass in this way is one of the most attractive features of dielectric heating.

Among plastics it seems likely that the process will be limited to materials which show an absorption band, that is, a more or less sharp maximum power factor in the radio-frequency range : other materials would require excessive voltages in order to generate sufficient heat. Thus the heat may be considered to originate in oscillations of the polar groups of the materials under the action of the alternating electric field. The question was raised : Is it possible that such heating at particular frequencies may be associated with special chemical activity, and therefore be of special value in processes like the curing of resins ? There appears, however, to be no evidence to suggest that such processes are stimulated by an electric field and selective as to frequency.

The advantages that may be gained by dielectric heating are so great that it may well revolutionize many industrial processes. It is, however, necessary to recognize that it has its limitations. First, as a method of generating heat it is bound to be expensive. In order to get the energy into the form of a high-frequency electric field, it must go through various transformations : low-voltage A.C. to high-voltage A.C. ; then to high-voltage D.C. via rectifiers ; then via thermionic valves to the final form. Each transformation requires equipment which may be expensive, and valves being high-resistance generators necessarily involve considerable losses of energy. The result is that dielectric heating cannot compete with ordinary electric heating (conductor heating) or steam heating for processes in which these are effective and not unduly slow. There is also the difficulty of avoiding interference with radio communication. This can, of course, be done by adequate screening, but this adds to the cost and may limit the ease of operation of the process.

A more fundamental limitation arises from the fact that the conditions for uniform heating are not always easily realized, and when uneven heating occurs there may be a risk of damaging the material. There is no maximum temperature which cannot be exceeded, like that of the steam in steam heating. In certain conditions the process is an unstable one. Thus if, as is not uncommon, the dielectric constant and power factor of a material increase with rise of temperature, then the effect of a rise of temperature is to increase the rate of heating, so that the action is cumulative. If this occurs throughout the mass, it will become obvious and the voltage will be reduced either by the operator or automatically as the heating proceeds. But if it is local, it may be undetected since it is the interior of the material that is usually hottest. Obviously then the material to be heated must be carefully controlled as to its uniformity and dielectric properties. Uniform heating will then be obtained provided the electric field is uniform. This again is not always a simple matter. A uniform field can be obtained between two plane parallel electrodes large in comparison with their distance apart, but as the distance apart increases in relation to the size of the plates there is a concentration of field near the surface of the metal. Occasionally this may be useful in counteracting the cooling effect of the electrodes ; but in other cases it is necessary to have an air gap between the material and the electrodes to avoid excessive heating of the surface layers.

There can be little doubt that the process will lead to important developments in plastics technology. The ability to heat large thicknesses uniformly makes possible the manufacture of laminated material such as is used for gear wheels in thicknesses previously unknown, and should make possible the production of thicker mouldings. The rapid jointing of materials like leather and fabrics with thermoplastic cements should be possible for sheets of any thickness, while the welding of thermoplastics of any thickness also becomes a possibility. The search for plastics of low power-factor which has had such striking successes in recent years may now be followed by one for materials of very high power-factor in some particular frequency range specially suited to dielectric heating.

The last subject discussed was the breakdown of insulating materials by the process technically known as 'tracking'. This is a localized, but progressive, charring, which, starting at one point, spreads more or less rapidly as a tree-like growth right across the surface of the insulator, finally short-circuiting it and carrying so much current that the insulator is destroyed by the heat generated. In opening the topic, Mr. E. Rushton explained that it is essentially a surface phenomenon, which only takes place on insulators which have been in service for some time, and only occurs in a humid atmosphere. That it is a surface phenomenon is shown by the fact that it can be to some extent prevented by coating the surface of the insulator with special varnishes, but there are the most diverse views as to the nature of the process, and correspondingly diverse opinions about suitable tests for the grading of materials for their tendency to fail by tracking.

It is generally agreed that the phenolic resins are on the whole more liable to fail in this way than urea resins, and it was stated that melamine resins are even better than urea ones in this respect ; but it was suggested that the difference is more likely to be one of macro-structure than molecular constitution. The final stage of the process is clearly dependent on a heterogeneous surface structure ; but how far this is characteristic of the resin itself and how far dependent on the chemical effect of surface moisture under the sustained voltage gradients in the surface is still a matter of conjecture. Stäger has described the process as analogous to the fatigue corrosion of metals, and dependent on the salt content of the materials, which gives rise to mobile ions in the films of water on the surface in a humid atmosphere. These ions moving under the action of the surface

voltage gradients lead to local deposits of salt and local concentrations of field strength, and therefore to local heating, which starts the formation of a conducting track of carbonized material. Once it has started it will inevitably travel down the voltage gradient, for it will behave like a pointed conductor at the tip of which there will always be a strong concentration of field strength and therefore local heating when the surface conductivity is appreciable.

Another view put forward was that tracking is always started by sparking over the surface, the steep voltage gradient required to produce a spark arising where the surface of the insulator becomes partially bridged by patches of relatively high conductivity, leaving narrow gaps of low conductivity to support an undue share of the total voltage. The conducting patches may arise from dirt or irregular wetting as the humidity rises.

Tracking can certainly be deliberately initiated by applying a high voltage and so causing sparks to pass over an insulating surface between electrodes with sharp edges, or alternatively by spraying the insulating surface with salt solution and so causing irregular wetting while a comparatively low voltage is applied; and these methods are used as rapid tests of the tendency of materials to break down by tracking. Their reliability as an index of performance in practice is not, however, universally conceded. A quick test would be of great practical importance in the development of 'anti-tracking' plastics, but a controlled procedure which will reproduce accurately the essential conditions will only be possible when the phenomenon is better understood.

Dr. Haefely somewhat ruefully summarized the immediate practical results of the meeting by saying that, as a manufacturer, he would, under present conditions, have to continue to make the best materials he could, to wait for apparatus for dielectric heating, and to design his electrodes so as to discourage the initiation of tracking.

L. HARTSHORN.

SCIENCE AND ART AT THE ROYAL ACADEMY, 1944

By DR. A. T. HOPWOOD
British Museum (Natural History)

IN 1942 I attempted[1] to explain what I understand art to be. Since some of my gossips later took me to task because neither beauty nor truth were mentioned, it may be well to point out that beauty is not essential to a work of art, and that truth is an ambiguous word often used to mean accurate representation.

Consider, for example, the numerous flower pieces in the present Royal Academy Exhibition; these range from highly finished coloured drawings to mere blobs of paint placed in such a way as to give the impression of flowers. A botanist or a gardener will probably prefer the former, since the flowers are easy to identify, and that makes for self-confidence in the observer, who feels that he understands what the painter is trying to do, though whether that feeling is justified is perhaps another matter. An artist, on the other hand, may well prefer the blobs; he thinks more in terms of harmonies, contrasts and design, and notices how the whole is enlivened by discreet touches of discordant colour, and how by proper emphasis the whole thing is made to hang together. In the popular sense of the word, only the first type of painting is true, whereas in fact both are true. Provided that this ambiguity is recognized, one is justified in the claim that truth is an essential component of art; but it was to avoid any misunderstanding that I spoke of intellectual honesty instead.

With so high a standard in the exhibits, the critic this year is fortunate in his lot. There are numerous items to which one would like to direct attention, but most of them are excluded by the title of this notice. Of those which remain, pride of place must be given to "Night Raid, 1941" by Richard Eurich (No. 710). Although it was painted "for the Nation's War Records", this work has about it a quality which lifts it above the competent journalism of the average war reporter. The canvas is full of incident, it tells not one story but many; the contrast between the hot fiery glow and the cold glare of the searchlights is admirably handled, but the hard white mount is not so well inspired. More than all these is a quality of innocence, as though the artist had approached his subject with the unspoilt mind of a child and recorded the night's events with a simple directness which more sophisticated minds would label primitive. "Antwerp" (No. 17) by the same artist is in a different mood; it was painted before the War began and is one of the Chantrey Bequest purchases; good picture though it is, "Night Raid" is better.

In so far as it is possible for one artist to steal the show, that has been done by A. R. Thomson. Look at his two pictures, "Apple Trees" (No. 97) and "Miss Joan Chapman" (No. 102), which hang a few feet apart in Gallery II. The trees really grow out of the grass; the spraying and the pruning may have been neglected, but the whole picture is redolent of the average farmer's orchard. In complete contrast is the relaxed body of the dancer, whose weight is taken down well and truly to the right foot. Then go round the corner and read the character of the chairman of the London County Council in his portrait (No. 224), and, finally, look at the young airmen having a happy night in the mess before "Going to be Decorated" (No. 754). Such versatility does not appear very often.

As for the purely scientific aspects of the Exhibition, the anatomist should enjoy the portrait of Miss Chapman just mentioned, and medical men Nos. 292 and 746—the titles are too long to quote. The portrait of Sir Henry Dale by Francis Dodd (No. 140) is not convincing, and that of Sir John Russell by Francis Hodge (No. 335) is irritating because the direction of the sitter's gaze, towards the bottom left corner of the frame, continually leads one's eyes away from the centre of the picture and distracts the attention. Here, too, may be mentioned Francis Dodd's charcoal drawing of Sir Charles Sherrington (No. 977) and Alfred Hardiman's bronze, "Study of a Scientist" (No. 1177).

Zoological subjects are few; most of them are horses which, apart from those by A. J. Munnings, P.R.A., are not particularly good. The best is the group to the right of the centre in Munnings' "Winter Meeting" (No. 17). Not only does the necessary foreshortening pose a difficult problem in perspective, but also the design made by the animal's feet is well-conceived; moreover, the horse and its rider are full of life and motion. One of the most curious

paintings is "Bringing up the Horses" by James Bateman (No. 169), in which the dark horse is so good whereas the grey is a pantomime 'prop'. In the Sculpture Gallery, "Shire Horse" by Barbara Waller (No. 1237) is conventional, but still a Shire. "Gazelle" by Alfred Oakley (No. 1243) is also conventional, with horn-buds more closely resembling those of the red deer than those of a gazelle.

Since the entomologist rarely has anything of his own, he may care to look at "Butterfly Tree" by Constance Stallard (No. 867). Neither the butterflies nor the shrub will cause him any difficulty.

Among the pictures of birds are, "Chinese Geese" by Jessie Hodge (No. 566), "Solway Company" (No. 900), "Geese and Mallow" (No. 903), and "The Covey" (No. 904), these last by C. F. Tunnicliffe. All four are illustrative of the difficulty of dealing with pictures of 'scientific interest', for they are so close to Nature that the slightly conventional drawing and not quite accurate colouring are apt to be disturbing rather than sympathetic. That painters approve of them is shown by the fact that Mr. Tunnicliffe's drawings have been purchased out of the Stott Fund, whence one may conclude that the fault lies with the critic and not with the artist.

Another type of problem is afforded by the work of Sidney Lee. This artist's favourite colouring, which inevitably brings to mind the old jingle "Greenery yallery, Grosvenor Gallery", is admirably suited to work in the Pennines—"Over the Hills" (No. 138)—but it does not carry conviction elsewhere, even when, as in "Thun" (No. 109), it is used with caution. Algernon Newton seems to have a similar difficulty: his canal scenes are among the very best of their kind, but when he tries to render "A Yorkshire Landscape" (No. 488) or "September" (No. 483) with the same palette the results are deplorable.

Much good work is to be found in the room devoted to black and white, including a number of architectural subjects. The fact that duplicate prints are often obtainable, with a corresponding increase in the number of red stars on the frame, enables one to estimate the public taste. This year the very attractive "Jenny Wren" by Winifred Austen (No. 1055) is without doubt the most popular.

The Architectural Room is dominated by the immense "Plan of London Communications" which ought to have a special note to itself. Suffice it to say here that, by an ingenious planning of the roundabouts, pedestrian, slow and fast traffic are all kept apart and that, to quote its authors, "the leisurely and carefree conditions of the old market place have been restored, though developed and improved to suit modern life". From the market place one's thoughts turn naturally to the home, only to be disappointed. Two years ago I protested against some houses designed for erection in the Wirral. Since then they have been built and photographed, and their photograph hangs on the Academy wall (No. 1106), to prove that for depressing ugliness there is nothing to surpass them in the back streets of Manchester or Leeds. To the various authors of these and other plans (Nos. 1098, 1102, 1111, 1117) may be recommended the wise words of the Royal Academy Planning Committee, "It is important to avoid the mechanistic character of extreme modernism, with its soulless or even frightening aspect of the merely functional. A more human and friendly character is required for the surrounding scene of the people's life and business."

[1] NATURE, 149, 603 (1942).

OBITUARIES

Dr. C. B. Davenport

DR. C. B. DAVENPORT, who died on February 18 at the age of seventy-seven, was one of the pioneers of genetics in the United States. He was born at Stamford, Connecticut, in 1866, and graduated from Brooklyn Polytechnic at the age of twenty. From then until 1899 he was associated, in various capacities, with the Zoology School at Harvard. In 1899 he moved to Chicago, only to return east in 1904 on his appointment as director of the Carnegie Institution Station at Cold Spring Harbor. It is in connexion with this Station that Davenport will be mainly remembered, for he remained there some thirty years until his retirement, and left it occupying the position of one of the leading centres of genetical research in the world.

An interest in natural variation developed early, and in 1899 we find Davenport publishing a small book, "Statistical Methods", where he outlined the biometrical approach to the collection and analysis of data on variation. With the rediscovery of Mendelism, however, fresh possibilities opened up and he began extensive investigations along these new lines using a variety of animals, especially poultry. The poultry experiments demonstrated Mendelian inheritance for many characters, though with complications in some cases. The results were published largely in the form of two extensive papers, dated 1906 and 1909, in the Carnegie Institution series. It is of interest to note that in the 1906 publication data are reported, from the F_2 of a cross between single-combed Black Minorca and white-crested Black Polish fowls, which supply evidence of linkage between the gene for crest and cerebral hernia on one hand and that for split and reduced comb on the other.

The application of genetics to man also attracted Davenport's attention, and in 1911 he published "Heredity in Relation to Eugenics". In this book is discussed the inheritance of a great variety of human traits from eye-colour, hæmophilia and cancer to insanity, criminality and pauperism. The hereditary aspect is brought out in all cases, though only in some of them do the data indicate a simple type of inheritance. The implications of these findings are discussed at some length in relation to migration (then a most active problem in the United States), sterilization, segregation of the unfit and so on. This interest in human heredity loomed even larger in Davenport's later work, when we find him writing on sex-linkage in man, the inheritance of twinning, the genetical factor in endemic goitre, crime in relation to heredity and other topics of the kind. His interest in the biometrical technique seems also to have at least partially revived in later years.

Davenport occupied a prominent position in contemporary American biology. He was a member of the National Academy of Sciences and served on the editorial boards of a number of scientific journals, notably *Genetics* and the *Journal of Experimental Zoology*. Of the many societies and associations to which he belonged those concerned with eugenical questions form a large part, and his work in this field was appropriately recognized in 1932 when he was made president of the Third International Congress of Eugenics, held in New York.

K. MATHER.

Prof. W. M. Thornton, O.B.E.

WILLIAM MANDELL THORNTON was born in Liverpool in 1870 and had his schooling at the Liverpool Institute. After eight years of practical work with an engineering firm he entered the University College (now the University) of Liverpool, where he worked under Lodge and Carey and graduated in the honours schools of physics and engineering. He was senior lecturer in engineering in the University of Bristol during 1896–98, lecturer in electrical engineering in Armstrong College (now King's College), Newcastle upon Tyne, from 1898, and was appointed to the chair of electrical engineering when this was inaugurated in 1906. On retiring from the chair in 1937, he was elected professor emeritus of the University of Durham.

Thornton took a lively interest in the work of the Tyneside engineers and was elected chairman of the North Eastern Centre of the Institution of Electrical Engineers for the year 1905–6 and again for 1921–22. He was president of the Association of Mining Electrical Engineers in 1920–21 and president of the Institution of Electrical Engineers in 1934–35. In 1920 he was decorated with the Order of the British Empire, and more recently the Greenwell Gold Medal was conferred upon him by the North of England Institution of Mining and Mechanical Engineers for his researches on gaseous and dust explosions in mines.

An account of Thornton's achievements is an indication of the scope and fervour of his mind ; so too are some ninety original papers which he contributed to the scientific and engineering journals. His thought moved naturally in terms of physics and mathematics, but his early training taught him to understand the problems of practising engineers ; and his great humanity made him eager for the vigorous growth of applied science. His research on gaseous and dust explosions, the work for which he is perhaps most widely known, had its inspiration in a visit which he paid to a colliery where an explosion had occurred. The damage and injury which he saw made an impression which was never obliterated. He described his feelings recently when speaking of it—"Surely we should be able to prevent this". The work he extended later at the suggestion of the Institution of Electrical Engineers and the Medical Research Council with the object of increasing the safety in operating theatres where ether is used as an anæsthetic.

Thornton also investigated with enthusiasm the problems of high-voltage measurement, the operation and design of electrical machines, the theory of dielectrics and the electrical conductivity of bacteria. During his last illness he looked forward constantly to his return to the laboratory.

It is not surprising that as a teacher Thornton could bring to his students the feeling that new discoveries were always within their reach, and, guided by him, undergraduate and postgraduate investigation flourished. His zest for research and his delight in discovery were at once apparent ; you went further and knew that the happiness which he communicated arose from something deeper than an untiring intellectual appetite, and that in him the whole man was happy because grounded upon a confident faith.

In spite of his many preoccupations Thornton was always accessible : always ready to listen and understand. All who knew him were proud to feel themselves his friends. "Few, in general estimation, are sincerely praised : few can evoke both wide and deep affection." Of these few Thornton was one.

J. C. PRESCOTT.

Dr. E. C. Scott Dickson

DR. E. C. SCOTT DICKSON, senior lecturer in physics in the University of Manchester, died at his home in Manchester on April 8.

Younger son of Lord Scott Dickson and nephew (by marriage) of Sir James Dewar, Dickson was born at Edinburgh in 1888. He was educated at Edinburgh Academy and Trinity College, Cambridge, where he took the Natural Sciences Tripos. Later he proceeded to the University of Bonn, and worked under Prof. Kayser for two years, taking a Ph.D. degree for research on the ultra-violet fluorescence of the benzols. In 1913 he was appointed demonstrator in physics in the University of Toronto. During the War of 1914–18 he served in India and in Mesopotamia with a battalion of the Highland Light Infantry.

In 1919 Dickson was appointed to a lectureship in physics in the University of Manchester, and continued his work there under Prof. W. L. Bragg and later Prof. P. M. S. Blackett until his death.

During his earlier years at Manchester, Dickson took part in the research work on crystal structure problems under Bragg. But his chief work in Manchester, for which he will be remembered, was as a physics teacher particularly of elementary students. In recent years he had charge of the physics teaching of medical students, and he organized this with characteristic thoroughness and keenness. He gave much time and thought to their interests and was always on the look-out for new ways of interesting medical students in physics and its applications to medicine. Apart from being an able physicist, Dickson had a very wide range of interests. He was exceptionally keen on music. During his student days in Germany he studied singing seriously with an intimate friend of Brahms. At Manchester he took particular delight in giving a special course of lectures on acoustics to a small group of students preparing for the Mus. Bac. degree. He was interested in all the arts and convinced of the value of classics in education, even for scientific men.

On the routine side of the work of the University, Dickson was a valuable member of the Faculty of Science and of the Faculty of Music. His loss will be particularly keenly felt during the period of reconstruction after the War, when such an experienced and wise university teacher and administrator as was Dickson would have rendered invaluable service.

J. M. NUTTALL.

WE regret to announce the following deaths :

Prof. W. E. H. Berwick, emeritus professor of mathematics in the University College of North Wales, Bangor, on May 13, aged fifty-five.

Mr. H. N. Dixon, the distinguished bryologist, on May 9, aged eighty-three.

Prof. Edward B. Mathews, emeritus professor of mineralogy and petrography at the Johns Hopkins University, on February 4, aged seventy-four.

Lieut. G. B. Wilson, information officer, South African Army, formerly director of the Rhodes-Livingstone Institute of Anthropology, Northern Rhodesia, aged thirty-five.

NEWS and VIEWS

Regius Chair of Zoology, Glasgow: Prof. C. M. Yonge

PROF. C. M. YONGE, professor of zoology in the University of Bristol, whose appointment as regius professor of zoology in the University of Glasgow is announced, is one of the most distinguished of the younger British zoologists. Receiving his early training at the University of Edinburgh, he has devoted himself for the last twenty years to the study of the interrelated physiology and morphology of marine animals, especially corals, molluscs and crustaceans. Beginning with his memoirs on the physiology of digestion in Mya (1923), Nephrops (1924) and Ostrea (1926), he has published a long series of admirable papers on the functional morphology of the Mollusca, and later on the remarkable functions of chitin and cuticle in the Crustacea, in relation to moulting and oviposition. His work on corals and their enclosed zooxanthellæ dates from his participation as leader in the Great Barrier Reef Expedition during 1928–29, and was later continued at the Tortugas Laboratory of the Carnegie Institution. In all these studies, his interest has lain in function and adaptation, in the activities of the living animal in relation to its structure and its environment, and he has been at pains to link up physiological and morphological facts. He takes a biological, rather than a physiological or morphological, view of the living animal, thus adding greatly to the significance and interest of his results. In the course of his studies he has travelled widely, visiting many of the principal marine biological stations throughout the world.

In addition to his scientific papers, Prof. Yonge published in 1930 "A Year on the Great Barrier Reef", and collaborated with Mr. F. S. Russell in "The Seas", a fascinating introduction to marine biology. He is an active member of the Development Commission's Advisory Committee on Fishery Research and of the recently appointed Committee on Post-War Fishery Research. While professor of zoology at the University of Bristol, a post which he has filled since 1933, he has been successful in stimulating research by his staff and students, promoting in recent years a co-operative study of the biology of the Bristol Channel. There is no doubt that he will be equally successful at Glasgow, especially with the facilities of the Millport Marine Biological Station close at hand.

Medical Services for India

FOR his address delivered at the Founder's Day Celebrations of the Lady Hardinge Medical College for Women, New Delhi, on March 17, Major-General J. B. Hance, director-general of the Indian Medical Service, took as his subject the need in India for a rapid and wide development of medical services, and he discussed the part which women will play in it. His address may be compared with Dr. Krishnan's presidential address to the Section of Medical and Veterinary Sciences at the Indian Science Congress held in January (see p. 658 of this issue). There is now, said General Hance, complete agreement throughout the world that health is a basic human right. Outlining the conditions required for 'positive health', he said that it is the goal of Indian medicine to provide these for every man, woman and child in India. The task is, as he and Dr. Krishnan clearly show, a formidable one; but it is no less evident that no responsible authority in India is going to shrink from it. The basis of the effort must be, General Hance emphasized, not this or that political philosophy, but "the united and indomitable will of the whole people to place their country on the map of modern civilised progress". Like Dr. Krishnan, he referred to the medical progress made in the U.S.S.R. during the last twenty years and he insisted that this has not been due to the Marxian philosophy, but to the united will of the Russian people. Nor need the cost of the effort required be a deterrent, for Lord Keynes and Prof. A. V. Hill, secretary of the Royal Society, have both reminded us that money is the servant and not the master of policy. The Allied war policy has proved that this can be so, for, if money had governed the prosecution of this War, hostilities would have ended long ago in the victory of the immensely superior financial resources of the Allies.

Certainly the figures quoted by both General Hance and Dr. Krishnan prove that India's medical needs are great and urgent. A nation should have, General Hance said, a minimum of one doctor to every 1,500 of the population. The United Kingdom has one to every 1,000. India has one to every 10,000; it has 40,000 registered doctors to-day and requires 300,000. A similar need of nurses, health visitors, midwives, pharmacists and dentists indicates the magnitude of the task which faces Indian medical education, and this is only part of the whole problem. General Hance stressed the need for emphasis on preventive and social medicine. Tuberculosis is an urgent special problem in India as elsewhere, and half a million beds are required for tuberculous Indians, at least half of whom are women. The care of the blind, of whom there are some two and a half million in India, is another great task. Industrial medicine will become more and more important in India with the increasing pace of industrial expansion. Research and teaching are also essential and must be carefully developed and fostered. For all these tasks the services of medical women will be required and for some of them they are essential. There is a great and inspiring future for the young medical men and women of India to contemplate. There are, as General Hance said, many eager and capable hands reaching out to take up the torch handed on by their elders. They will, as they look out from India over land and sea, be inspired by the similar noble work being done by their fellow workers near at hand in the U.S.S.R. and China and farther away in the Americas. The busiest of them all in the next decade will be those who must work in the suffering lands of a Europe freed at last from famine and war.

Institute for the Study of Animal Behaviour

AT a meeting of the Council of the Institute for the Study of Animal Behaviour held on April 20 two new members of Council were co-opted. The full Council is now: Dr. E. S. Russell (*president*), Dr. R. J. Bartlett, Dr. R. W. Douglas, Dr. J. T. Edwards, Mr. James Fisher, Dr. E. Hindle, Dr. Julian S. Huxley, Mr. F. B. Kirkman (*hon. treasurer*), Dr. W. H. Thorpe, Dr. Arthur Walton, Mr. Alastair N. Worden (*hon. secretary*), and Prof. S. Zuckerman. Arrangements were made to publish a new number of the *Bulletin of Animal Behaviour*, and speakers were chosen for the joint meeting to be held with the Royal Society of Medicine (Section of Comparative Medicine) on June 21, as follows: Dr. C. S.

Myers (instinct), Dr. W. H. Thorpe (learning processes in animals), Dr. F. B. Kirkman (bird behaviour), Prof. D. B. Johnstone-Wallace (grazing habits of beef cattle), and Dr. Arthur Walton (comparative sexual behaviour in the male). It was agreed also that Prof. Samson Wright and other psychiatrists should be invited to speak at this or a succeeding meeting. Future research projects were discussed, especially those in the veterinary field; for example, the individual behaviour of various domestic species, the grazing habits of sheep and cattle, and the utilization of behaviour reactions in supplementing clinical, pathological and biochemical studies of domestic mammals. Certain ornithological studies, suitable for members, were also discussed. It was decided to circulate these projects at an early date. Consideration was given to the matter of research grants, and it was agreed to take steps to try to secure funds for specific observational studies involving domestic animals. Membership of the Institute is open to all interested persons. The annual subscription (12*s.* 6*d.*) includes payment for the *Bulletin of Animal Behaviour*. Communications should be addressed to the Hon. Secretary, Institute for the Study of Animal Behaviour, c/o Zoological Society of London, Regent's Park, N.W.8.

The War-time Social Survey

A PAPER on the "War-time Social Survey" was read at a meeting of the Royal Statistical Society on May 16 by Kathleen Box and Geoffrey Thomas. The War-time Social Survey is the Government social research unit, and has been set up to provide any department with information, needed for the planning and administration of policy, which is not available from other sources. It is concerned with social problems, in the investigation of which it aims at establishing facts and attitudes of the public towards these facts. The method used to achieve these ends may be described briefly as interviewing samples of the general public, or of particular sections of the general public, with a recording schedule devised so that the results of the inquiries made can be expressed statistically. Investigations are carried out by fifty-five trained fieldworkers, all women. The reception accorded to fieldworkers suggests that the public is ready to appreciate the importance of such inquiries and to give all possible help. The proportion of people eventually refusing to be interviewed is about 0·5 per cent in most inquiries. The Survey has had to rely very largely on devising its own techniques for different occasions as they arose. The experience gained by other workers in the field of social research, both in Great Britain and in the United States, has been used, and most members of the research staff, coming as they do from different organizations which have been doing allied work for many years, have had different contributions to make.

The Survey can provide a closer link between the administrator and administered than is normally possible, particularly in relation to the preparation and interpretation of departmental statistics. In each Department of State there has been a large amount of unco-ordinated statistics related to very limited aspects of the department's work. By the extension of the survey method such obstacles can be overcome. Thus the data which it is most convenient for a department to obtain by a return can be supplemented in many ways by sample inquiries and thus assist in making decisions of policy. In this way a most flexible instrument for the compilation of a wide range of statistics can be developed. At the same time each department can remain in close touch with the collection of data, since the Survey normally discusses an inquiry in great detail with the officers concerned before it goes into the field. The experience of the Survey has shown during the past two years that its work has satisfied a real need for a specialist body able to advise on aspects of social inquiry which go beyond the official return, and there is little reason to suppose that this need will disappear when the War comes to an end.

Illuminating Engineering Society

THE annual report for the past year of the Illuminating Engineering Society, presented at the annual meeting held on May 9, directs attention to the formation of new centres in Bath and Bristol, and new groups in Derby, Huddersfield and Stockton-on-Tees. The Society is now organizing its activities through seven distinct areas, each with its own committee which in turn is represented on the areas joint committee. 243 new members have been added to the Society during the past year; the number of meetings held, upwards of sixty, exceeds that in pre-war days. Recent educational efforts include the organization of essay competitions for pupils in schools near Birmingham, and the giving of a series of Christmas lectures on "The Wonders of Lighting" to more than a thousand children in Bradford. The Society has been instrumental in forming a joint committee, with which leading physiologists are associated, to deal with the physiology of vision, and has completed, for the Ministry of War Transport, a special investigation into the brightness and legibility of traffic signs. Three of the series of illustrated lighting reconstruction pamphlets, dealing respectively with "Principles of Good Lighting", "The Lighting of Schools" and "The Lighting of Public Buildings" have recently been issued. The following officers have been elected for the present session: *President*, Mr. E. Stroud; *Hon. Treasurer*, Mr. N. V. Everton; *Hon. Secretary*, Mr. J. S. Dow.

Early Medical Books at Edinburgh

To illustrate a current series of lectures by Dr. Douglas Guthrie on "The Historical Background to Modern Medicine", there has been placed on view a collection of early printed medical books in the Upper Library Hall of the University of Edinburgh. Founded in 1580 as a "Town's Library" three years before the foundation of the University, or "Town's College", the University Library remained the only public library in Edinburgh until the establishment of the Advocates' Library a hundred years later. Naturally it contains many treasures, including a number of works of medical interest from which the present selection has been made. The most important and valuable items in the exhibition are Vesalius's "De Corporis Humani Fabrica" and Harvey's "De Motu Cordis". The beautifully bound copy of the former is the first edition, from the press of Oporinus of Basel, 1543. Beside it lies the fine two-volume edition, printed at Leyden in 1725 by Boerhaave and Albinus. The first edition of Harvey's account of the circulation of the blood is now an extremely rare little book, dated from Frankfurt, 1628. Visitors to the exhibition will have the opportunity of seeing two perfect copies, one of which belonged to Alexander Monro, the third of the dynasty of professors

of anatomy of that name. The first Alexander Monro, when appointed to the chair in 1720, kept a list of his students which is now shown, as also is a printed copy of the first thesis to be presented for the degree of M.D., Edinburgh. It is entitled "De Dolore", by John Monteith, and the date is 1726. Later works on view are the second edition (1800) of Edward Jenner's "Inquiry into the causes and effects of variolae vaccinae", the first British edition of Beaumont's "Experiments and Observations on the gastric juice, etc." (1838), Morton's "Remarks on the mode of administering ether" (1847), and J. Y. Simpson's "Account of a new anaesthetic agent" (chloroform) (1847). Another landmark of medical literature is Lister's "Introductory Lecture", delivered in 1869 when he succeeded James Syme in the chair of clinical surgery at Edinburgh, and with it may be seen a manuscript set of notes of Lister's lectures, in the writing of one of his most distinguished students and successors, Prof. Caird. A feature of the exhibition, and the most spectacular item, is a fine collection of illustrated herbals, including a magnificent copy of "De Historia Stirpium", by Leonard Fuchs, dated 1542, with coloured wood-cuts, and a catalogue of the Physic Garden of Edinburgh (1683), by the first professor of botany, James Sutherland. The exhibition, which has been arranged through the kindness of Dr. L. W. Sharp and the Library Committee of the University, will remain open until June 3.

Rhinology and Folk-Lore

IN a recent paper (*J. Laryng. and Otol.*, **57**, 272; 1943) on this subject, Dr. J. D. Rolleston remarks that in contrast with the dearth of popular synonyms for the ear and larynx, the nose enjoys an abundance of such terms, which he suggests is mainly due to the prominent position which the nose occupies in the face. Another explanation of these numerous synonyms is the connexion of a large red nose with chronic alcoholism, though such a connexion has been greatly exaggerated. One of the earliest beliefs connected with the nose is that it is the portal of entry of the life or the soul, as is seen from the well-known passage in Genesis relating to Adam. On the other hand, according to Sir James Frazer, the nose has been regarded by several savage races as the path by which life leaves the body. A popular belief in a close relationship between the size of the nose and the sexual organs in both sexes dates back to ancient times, and seemed at first to be confirmed at the end of the last century by the work of Fliess and others, who under the title of 'reflex neurosis' recorded a number of cases of uterine disease which had been cured by treatment of abnormal conditions of the nose. It now appears that the supposed connexion between the two organs in both sexes has been greatly exaggerated.

The folk-lore connected with sneezing is extremely abundant and dates back to remote ages, as is exemplified by many passages in the Bible, Homer, the Greek anthology, Xenophon and Petronius Arbiter. In accordance with the general rule in medical folk-lore, preventive measures are remarkably scanty in the case of rhinology and are chiefly employed in the management of epistaxis; whereas therapeutic measures are extremely numerous and can be classified under the headings of remedies of human origin, animal remedies, plant remedies, mineral cures, hydrotherapy, charms, patron saints and miscellaneous cures.

William Bartram of Philadelphia: Naturalist and Traveller

THE son of John Bartram, botanist to His Majesty for the Floridas, William Bartram (1739–1823) shared his father's interest in Nature, and in 1773–74 carried out an extensive survey in Georgia and Florida. The results of his "Travels" he communicated in two manuscript volumes to his patron, Dr. John Fothergill, an Edinburgh medical graduate who had settled, and made a fortune, in London. After the death of Fothergill, the manuscripts came into the possession of Sir Joseph Banks, and they are now in the library of the British Museum (Natural History). Through the generosity of the American Philosophical Society and the John Bartram Association, this interesting record, thoroughly annotated by Francis Harper, has just been published (*Trans. Amer. Phil. Soc.*, N.S., **33**, 121; Nov. 1943). It gives a picture of the primeval wilderness of the south-east of North America, of the beauties of scenery and the wonders of plants and animals, of the Creek, Cherokee and Seminole Indians, until then largely unspoilt by the 'civilization' of white men. It is true that many of the wonders described by Bartram were regarded with scepticism in later years by those whose authority gave them some claim to pronounce judgment; but it is one of the gratifying features of the investigations of Mr. Harper, who followed the Bartram trails over some ten thousand miles, that the authorities have been confounded and Bartram's accuracy vindicated, even in the much-disputed matters of the painted vulture of Florida and the bellowings of the alligators of St. John's, Florida, so circumstantially figured in the traveller's drawing, reproduced as Plate xiv in this paper.

Railway Signalling on London Transport

ACCORDING to a paper read recently in London by R. Dell before the Institution of Electrical Engineers, the power-signalling installation on the railways of the London Passenger Transport Board now covers 160 miles of double track. There are 3,281 stop signals, 2,726 of which are fitted with train-stops. Track circuits number 4,347 and there are 1,326 pairs of points. Although automatic signals are used wherever possible, 112 signal cabins are in use at junctions or connexions in the track layout. The passenger-train car-miles run each year total approximately 159,150,000. Power signalling has been in use practically throughout the system since it was electrified. The electrification of the District Line and the installation of power signalling commenced in 1904 and was completed by the end of 1905. The London Electric Tube Lines were equipped with power signalling from the start—the Bakerloo and the Piccadilly Lines in 1906 and the Hampstead Line in 1907. The Central London Railway was converted to power signalling in 1913 and the City and South London Railway in 1919. Except for these last two installations, the whole of the signalling system was originally operated on D.C. and track circuits were of the D.C. type with polarized relays in order to avoid improper operation by stray current from the traction system.

In the original installation the signals were all electro-pneumatically operated, with a moving spectacle in front of a fixed light for the tunnels and with semaphore arms in the open. All signals for passenger movements were provided with automatic trainstops. Although they gave remarkably satis-

factory results, the D.C. track circuits were not entirely immune from interference by stray current from the traction system; as a result, practically the whole of these track circuits have been replaced by A.C. equipment. At the same time, many additional safeguards were added to the system. Alternating current is now employed throughout for all signalling circuits as well as for the track circuits themselves.

Recent Earthquakes

During the period February 4–April 5, fifteen strong earthquakes were registered by the seismographs at Kew Observatory. The greatest of these were on February 29 and March 9. The shock of February 29 began recording compressionally at 16h. 40m. 22s. G.M.T. from an epicentral distance of 8,900 km., and after a full suite of pulses beginning with *iP* attained a ground amplitude at Kew of 110 μ at 17h. 18m. 53s. G.M.T. On March 9 the shock began recording impulsively at 22h. 13m. 06s. G.M.T. and attained a maximum ground amplitude at Kew of 420 μ at 22h. 43m. 49s. G.M.T. At Toledo (Spain) during February, twenty-four earthquakes were registered by the instruments. The greatest of these was on February 1 at 03h. 28m. 26s. from an epicentral distance of 3,700 km. (Turkey). This shock attained a maximum ground amplitude of 1150 μ at Toledo at 03h. 40m. 44s. Many after-shocks of this earthquake were recorded at Toledo during the month. Earthquakes which registered both at Toledo and Kew occurred on February 1, 4, 5, 15, 20 and two on February 29, the last of these having been mentioned above.

The first shock on February 29 occurred at 3h. 42·0m. G.M.T. Its epicentre has been found by the United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, to have been near lat. 13·7° S., long. 70·6° W., which is in southern Peru. The depth of focus was probably slightly less than 200 km. It was recorded at Kew on the vertical component seismograph with *iP* (dilatation) at 03h. 54m. 33s. G.M.T. and attained a maximum ground amplitude of 22 μ at Kew at 04h. 34m. 38s. G.M.T. At Toledo it was recorded at 3h. 54m. 00s., and attained maximum ground amplitude of 80 μ. The earthquake was recorded at Boulder City, Buffalo, Burlington, Chicago, Fordham, Georgetown, Huancayo, Pasadena, Philadelphia, St. Louis, San Juan, Sitka, Spring Hill and Tucson on the seismographs.

The Night Sky in June

Full moon occurs on June 6d. 18h. 58m. U.T., and new moon on June 20d. 17h. 00m. The following conjunctions with the moon take place: June 19d. 13h., Mercury 3° N.; June 24d. 17h., Mars 1° S.; June 25d. 02h., Jupiter 1° S. On June 24d. 17h. 38·3m. Mars is occulted by the moon, reappearance taking place at 18h. 54·2m. (for the latitude of Greenwich). Occultation of 308 *B* Leon. occurs on June 26d. 22h. 27·7m. (*D*), but there are no other occultations of stars brighter than mag. 6 during the month. Mercury rises at 3h. 11m. at the beginning of June and at 3h. 38m. at the end of the month. Venus is in superior conjunction on June 27, but is too close to the sun throughout the month to be well observed. Mars, in the constellation of Cancer, sets at 23h. 46m. and 22h. 33m. at the beginning and end of the month respectively. Jupiter, in the constellation of Leo, sets at 0h. 15m. and 22h. 30m. at the beginning and end of June respectively. Saturn is drawing close to the sun and is becoming difficult to observe. It sets at 21h. 17m. at the beginning of June—a little more than an hour after sunset. Summer Solstice commences on June 21d. 13h.

Announcements

Dr. W. J. Hall has been appointed assistant director of the Imperial Institute of Entomology as from June 1. Dr. Hall was a senior entomologist in the Ministry of Agriculture, Cairo, during 1920–26, and afterwards entomologist and director of the Mazoë Citrus Experimental Station and superintendent of the British South Africa Company's Citrus Estate at Mazoë.

Mr. Henry Clay, economic adviser to the Bank of England since 1933, has been appointed warden of Nuffield College, Oxford, in succession to Mr. Harold Butler.

The Association of Scientific Workers has signed an agreement with the Engineering and Allied Employers National Federation, whereby the latter recognizes the Association as representing scientific and technical staff in the industry.

Two scholarships have been given to the Mining Department of the University of Leeds. The first, to be known as Dr. Walter Hargreaves Scholarship, has been founded with a fund of £1,250, collected by the shareholders of the Briggs Collieries, Ltd., as a testimonial to Dr. Walter Hargreaves on his retirement from the chairmanship of the Company. Dr. Hargreaves has been a member of the Mining Advisory Committee of the University for many years and its chairman for the last twenty years. The second has been founded by the Anglo-Saxon Petroleum Company, which has provided a scholarship of £60 a year, plus fees, tenable in the Mining Department.

The Progressive League has arranged a series of five lectures on "Psychology and Problems of Society", to be delivered on Wednesdays at 7.30 p.m. beginning on June 7, in the Conway Hall, Red Lion Square, London, W.C.1. The speakers and their subjects are: Prof. F. C. Flugel, "The Psychological Basis of Permanent Peace"; Dr. May Smith, "Some Psychological Problems of Industry"; Dr. E. Glover, "Reactionary Aspects of Present Day Psychology"; Barbara Low, "The Psychology of Propaganda"; Major Emanuel Miller, "Psychiatry in a Planned Society". Tickets are 5*s*. for the course, 1*s*. 6*d*. for single lectures, and can be obtained at the door or from the Secretary of the League, 20 Buckingham Street, London, W.C.2.

The British Council has been permitted to print a small edition of the *British Medical Bulletin* for sale in the United Kingdom. The primary purpose of the *Bulletin* is to interpret British medicine to the overseas reader who would not normally consult the medical journals published in Great Britain. It contains reviews, abstracts, book notes and a list of the contents of current British medical and cognate journals. Applications for annual subscriptions (21*s*.) or for single parts should be addressed to the *British Medical Bulletin*, 3 Hanover Street, London, W.1.

Erratum. In the communication entitled "Gamones from the Sperm of Sea Urchin and Salmon", Nature, March 4, 1944, on p. 286, col. 1, line 18, for "*p*H less than 4·0" read "*p*H greater than 4·0".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Activity of the Phytase in Different Cereals and its Resistance to Dry Heat

WHEAT, oats, barley and rye all contain between 0·18 and 0·26 per cent of phytic acid phosphorus. Wheatmeals and flours also contain an active phytase, and considerable interaction between this enzyme and its substrate may accompany the preparation of wheat for the table[1,2].

It was observed by Mellanby[3] many years ago that oatmeal is more rachitogenic than wheatmeal, and, later, that hydrolysis with acid or germination and malting[4] can remove the anticalcifying properties of oatmeal. Recent work has helped to explain these last two pioneering observations, for it has tended to incriminate phytic acid as the rachitogenic agent in cereals. In trying to account for the difference between oats and wheat in terms of phytic acid, it was found that oatmeal as purchased has a negligible phytase activity. It is accordingly suggested that this lack of phytase may explain Mellanby's results[3]. It is certain that only the merest fraction of the phytic acid in oatmeal could have been destroyed in preparing his puppies' food, whereas much of the phytic acid in the wheatmeals might have gone over to inositol and inorganic phosphorus before the puppies ate it. The lack of phytase in oatmeal explains why little or no hydrolysis of the phytic acid in oatmeal takes place in the making of porridge, even if the meal is left to soak overnight and then brought slowly to the boil.

The lack of phytase in oatmeal as purchased was at first tentatively attributed to the kilning process to which 'green' oats are subjected before being milled. Samples of kilned oats and of the green oats from which they had been prepared were, however, obtained from four well-known Scottish firms. These were ground up and incubated with ten times their weight of water at 50° C. and pH 4·5 for varying lengths of time. Two observations were at once made. The first was that the phytase activity even of 'green' oats was never more than a fraction of that of either English or Manitoba wheat. This led to an examination of rye and barley, and the results of all these tests are given in Table 1. It will be seen that the rye phytase was the most active. The inclusion of rye such as this in a wheaten grist would, therefore, tend to increase the amount of phytic acid destroyed in baking the bread, and the destruction in a rye bread must sometimes be very high. Dr. Kent-Jones kindly baked some rye bread from sample 2 according to the German technique[5], and 48 per cent of the phytic acid in this whole rye flour was found to have been destroyed in spite of the short time allowed for the bread to 'rise'.

It might be supposed that the apparent lack of activity of oatmeal phytase is due to this cereal containing a different and perhaps more resistant phytic acid; but this is unlikely, for when oats and wheat were boiled with hydrochloric acid the rates of hydrolysis of the phytic acids of the two cereals were found to be exactly the same (Table 1). Nor can the slow rate of enzymic hydrolysis in oatmeal be attributed to its phytic acid being present in a particularly insoluble form for, although the various samples of oats contained 44–72 mgm. of calcium per 100 gm. as against 29–41 mgm. for the other cereals, at least 75 per cent of the phytic acid in the oats was present as the magnesium and potassium salts, both of which must have been in solution at pH 4·5.

TABLE 1 RATE OF HYDROLYSIS OF PHYTIC ACID IN DIFFERENT CEREALS.

Nature of cereal	Phytic acid P. in cereal mgm. per 100 gm.	Hydrolysing agent	Time required for hydrolysis of 50% of the phytic acid
		Phytase in cereal itself at 50° C. and pH 4·5	
Rye, Sample 1	242		5 min.
,, ,, 2	217	,,	8 min.
Wheat, English	242	,,	12 min
,, Manitoba	233	,,	14 min.
Barley	260	,,	43 min.
Oats, Green (N.S.)	233	,,	11 hr
,, ,, (J.J.)	210	,,	11 hr.
,, ,, (J.I.)	182	,,	13·5 hr.
,, ,, (W.E.)	198	,,	15 hr.
Oats, Kilned (N.S.)	220	,,	30 hr
,, ,, (J.J.)	218	,,	46 hr.
,, ,, (J.I.)	223	,,	46 hr.
,, ,, (W.E.)	206	,,	40 hr
Wheat, English	242	Boiling $2N$ HCl	7·1 hr.
Oats, Green (J.S.)	182	,, ,,	7·1 hr.

TABLE 2 THE PHYTASE ACTIVITY OF BRAN (AS MEASURED BY THE DESTRUCTION OF PHYTIC ACID) AFTER THE BRAN HAD BEEN HEATED DRY AND IN WATER AT 90° C.

All samples were incubated for 50 min. at 50° C. and at pH 4·5. The bran originally contained 10·3 per cent of moisture and 0·92 per cent of phytic acid phosphorus.

Time of heating at 90° C. (hr.)	% Destruction of phytic acid during incubation	
	After dry heat	After wet heat
0	87	87
½	87	0
1	85	0
2	82	0
5	78	0

The second observation was that kilning, even at temperatures of 260–360° F. for two and a half hours, did not destroy *all* the phytase. It was thought possible that this might be due to the enzyme being resistant to heat once it was dry. This was subjected to test. Some wheat bran was dried over phosphorus pentoxide in a serum-drying plant and afterwards heated in the dry state at 90° C. for ½, 1, 2 and 5 hours. Other samples were dropped into water at 90° C. and maintained there for the same times. The activity of the phytase was then studied by measuring the rate of destruction of the phytic acid in the bran on incubating it at 50° and pH 4·5. The results are given in Table 2, and it will be seen that whereas, as expected, the enzyme was completely and instantaneously destroyed in water at 90° C., it suffered no measurable destruction in 30 minutes at this temperature when it was heated dry, and very little destruction even after five hours. Further observations are in progress on the resistance of other enzymes to dry heat.

Our thanks are due to the millers who supplied the oats, to Dr. Greaves for drying the bran, to Drs. Moran and Kent for grinding the cereal grains for us, and to Dr. Kent-Jones for baking the rye bread. One of us (E. M. W.) is in the whole-time service of the Medical Research Council.

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[1] Widdowson, E. M., NATURE, 148, 219 (1941).
[2] Pringle, W. J. S., and Moran, T., *J. Soc. Chem. Ind.*, 61, 108 (1942).
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Production of Gliotoxin by *Aspergillus fumigatus* mut. *helvola* Yuill

IN the Research Items in NATURE of April 29, an account is given of the production of antibiotics by *Aspergillus fumigatus*. To supplement this annotation we submit this short account of our own work with the mould *Aspergillus fumigatus* mut. *helvola* Yuill. An earlier publication[1] has described the isolation of helvolic acid from 2–3-week cultures of this mould grown at 25° C. on a medium containing mineral salts and 4 per cent of glucose.

Discrepancies between the antibacterial activity of the culture medium, particularly during the first few days of growth, and the yield of helvolic acid obtained, suggested the presence of a second antibacterial substance. It was found that whereas the antibacterial activity of a 20–22-day culture is scarcely diminished at all by maintaining it at *p*H 10 for 5 hours at 37° C., this treatment completely destroys the activity of 3–4-day cultures. Since helvolic acid itself is stable at *p*H 10 under these conditions, it is clear that in the early stages of growth a second antibiotic, sensitive to very dilute alkali, is produced.

Investigation showed that the activity of the medium reaches a maximum after 8–9 days, then drops somewhat to reach a minimum after 16–17 days, after which it again rises to reach a fairly constant value after 20–22 days. At this time the mould is usually harvested for the isolation of helvolic acid. To isolate the second antibiotic, 5–6 day cultures are brought to *p*H 10 and immediately extracted thrice with equal volumes of chloroform, the total volume of chloroform being equal to the volume of medium being extracted. The chloroform extract is distilled under reduced pressure and the solid residue crystallized several times from hot alcohol. This process yields long colourless needles of the second antibacterial substance, the weight obtained being, roughly, 30 mgm. per litre of culture medium.

For the isolation of helvolic acid in this laboratory a magnesia column is used[1] and this is eluted with hot water. Under these conditions, the alkali-sensitive material is destroyed. We have identified the second antibiotic as one already described, gliotoxin, first obtained[2] as a metabolic product of the mould *Gliocladium fimbriatum* Gilman and Abbott. Our identification is based primarily on the data of Johnson, Bruce and Dutcher[3], who have investigated the properties of gliotoxin in considerable detail.

Property	Gliotoxin	Data of Glister and Williams
Melting point*	221° C.	218–220° C.
Optical activity	$[\alpha]^{25}_{D} = -255° \pm 15°$ (0·1% in $CHCl_3$) $[\alpha]^{25}_{D} = -290° \pm 10°$ (0·08% in C_2H_5OH)	$[\alpha]^{20}_{D} = -254°$ (0·6% in $CHCl_3$)
% Carbon†	48·08	49·9
% Hydrogen	4·96	4·4
% Nitrogen	8·15	9·5
% Sulphur	19·29	19·3

* In common with other authors we find that this value is obtained only if heating is very rapid.
† Analyses by Weiler and Strauss. Material dried at 50° C. *in vacuo*.

The molecular weight determined by an X-ray method (D. Crowfoot and B. W. Rogers-Low) is 330 ± 8. Johnson *et al.*[3] give 314 as their best value. The absorption spectrum, examined by Dr. E. R. Holiday, is consistent with the findings of these workers[3] that gliotoxin is an indole derivative.

The antibacterial activity of our material has been determined by Dr. M. A. Jennings, of this Department. In serial dilution tests, in which one drop of a 16-hour bacterial culture, diluted 1 : 1,000, was added to 5 c.c. quantities of nutrient broth containing diminishing amounts of gliotoxin, the minimum concentrations required to inhibit growth completely were:

Staph. aureus ..	.. 1 : 360,000
S. Typhi ..	.. 1 : 45,000
Bact. coli ..	.. >1 : 45,000

The sensitivity depends very much on the size of inoculum; for example, when the inoculum of *Staph. aureus* was increased a thousandfold, the minimum growth-inhibiting concentration was increased eightfold.

In the original publication[1] on helvolic acid, reference was made to fumigacin, an antibacterial substance obtained by Waksman and his collaborators[4] from *Aspergillus fumigatus* (Strain W84). The data then published were sufficient to establish that fumigacin and helvolic acid were not the same. In particular, fumigacin contains 3·7 per cent nitrogen (helvolic acid contains no nitrogen), 62·7 per cent carbon (helvolic acid, 69·1 per cent) and melts at 185–87° C. (helvolic acid, 212° C.). During the course of the present work, however, it has been shown[5] that fumigacin is a mixture of helvolic acid and gliotoxin. In view of this it seems rational to replace the term fumigacin, relating to a mixture of antibiotics, by the separate names gliotoxin and helvolic acid, which refer to chemical individuals. In this laboratory we have been able to obtain gliotoxin from 5–7-day cultures of a strain of *Aspergillus fumigatus* Fres. (Lister No. 982) kindly supplied by Dr. W. H. Wilkins, Mycology Laboratory, University Department of Botany. The mould was grown at 25° C. on Czapek-Dox plus 2 per cent glucose.

Shortly before submitting this note for publication, it was reported that gliotoxin has been obtained from a Penicillium as yet unidentified[6].

One of us (T. I. W.) is indebted to the Nuffield Fluid Research Fund for a grant towards expenses.

G. A. GLISTER.
T. I. WILLIAMS.
Sir William Dunn School of Pathology,
Oxford. May 1.

[1] Chain, Florey, Jennings and Williams *Brit. J. Exp. Path.*, **24**, 108 (1943).
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[5] Menzel, Wintersteiner and Hoogerheide, *J. Biol. Chem.*, **152**, 419 (1944).
[6] Johnson, McCrone and Bruce, *J. Amer. Chem. Soc.*, **66**, 501 (1944).

X-Ray Crystallography of Gliotoxin

WE have examined a specimen of gliotoxin prepared by G. A. Glister and T. I. Williams, as above. The crystals are four- and six-sided monoclinic plates elongated along [010], and our evidence on their morphology and optic character agrees very well with the measurements of Dr. W. C. McCrone[1,2].

The crystals gave good X-ray photographs from which the following data were obtained: $a = 18{\cdot}74$ A., $b = 7{\cdot}59$ A., $c = 10{\cdot}36$ A., $\beta = 80°$, correct to about ± 1 per cent; space group $P2$. Density = 1·543 ± 0·01.

Since the space group requires at least two molecules in the unit cell, the crystallographic molecular

weight of gliotoxin plus solvent of crystallization is 678 ± 16, or some submultiple of this. Chemical evidence suggests that the true molecular weight is of the order of half this, while the solvent lost on drying the crystals appears to correspond to the presence of $\frac{1}{2}$ H_2O per chemical molecule of gliotoxin (loss on drying, found 2·14 per cent, calc. 2·68 per cent). The calculated weight of half the crystallographic asymmetric unit, 339 ± 8, agrees very well with the figure 335 required for the formula $C_{13}H_{14}O_4N_2S_2.\frac{1}{2}H_2O$.

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May 1.

[1] Johnson, Bruce and Dutcher, *J. Amer. Chem. Soc.*, **65**, 2005 (1943).
[2] Johnson, McCrone and Bruce, *J. Amer. Chem. Soc.*, **66**, 501 (1944).

Formation of Hydrogen Ions in High Concentration by Ordinary Baker's Yeast

IN a previous letter[1] it was pointed out that when glucose is fermented by yeast, the release of hydrogen ions into the external solution can be greatly increased when buffering is avoided and the external potassium chloride concentration is much raised.

Previous fermentation for two and a half hours with 0·6 per cent glucose also assists in the subsequent acid production. After such preparative fermentation in the experiments here considered, 1 part of the yeast is well washed in the standard potassium chloride solution, and then left suspended in 0·5 part, and at a given time 0·1 part of 30 per cent glucose is added, samples of the mixture being taken and centrifuged after definite time intervals. The accompanying table shows the effect of increasing the potassium content in the external fluid, the samples being taken 20 minutes from the beginning of fermentation.

Potassium in centrifuged fluid		pH of the centrifuged fluid	Increase of free H ion conc. (allowing for activity correction) (mM./litre)	Decrease of potassium conc. (mM./litre)
At zero time (mgm./100 c.c.)	After 20 min. (mgm./100 c.c.)			
17	9	2·62	3	2
80	39	2·18	8	10
147	88	2 00	11·5	15
330	234	1 77	20	25
1760	1650	1·78	21	28

It will be seen that a pH as low as 1·7–1·8 (determined by the glass electrode) is reached when the potassium outside the cells is about $N/10$ with little or no further increase in the hydrogen ion release on increasing the potassium. The rise in the free hydrogen ion concentration accounts directly for much the greater part (about 75–80 per cent) of the potassium absorption after 20 minutes (the period of maximum potassium absorption), the remainder being probably also due to an exchange with hydrogen ion, the latter being slightly buffered by substances released during fermentation. What is of special interest here is the direct exchange of potassium for hydrogen ions, the latter reaching surprising levels. It is noteworthy that throughout the period of observation (up to 60 minutes) no appreciable change in the chloride content of the external fluid takes place.

As previously indicated[1] the source of the hydrogen ions would appear to be pyruvic or phosphopyruvic acid, though phosphoglyceric acid probably contributes also a slight amount. The pK values of pyruvic and glyceric acids are 2·5 and 3·6.

Where exactly the pyruvic acid is formed is at present obscure, except that it is almost certainly not formed throughout the yeast cell, but in some small surface region. In the external fluid, though pyruvic acid follows the potassium absorption (in inverse relation), it is present in very small concentration, and if liberated as the free acid, it could account for only a quite negligible fraction of the hydrogen ion concentration. This also applies to the total keto acids outside the cells.

It may be pointed out that free hydrogen ion in concentration indicated by a pH of 1·78 (and occasionally somewhat lower), in the presence of about $N/2$ chloride ion, is equivalent to free hydrochloric acid of approximately $N/50$ strength.

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[1] Conway, E. J., and O'Malley, E., NATURE, **153**, 555 (1944).

Fluorescence Spectra of Naphthacene Molecules in Solid Solution of Anthracene with the Variation of Wave-lengths

IN the crystalline state, pure naphthacene scarcely fluoresces, but it fluoresces with characteristic yellow-green light when mixed with anthracene or chrysene. Anthracene containing traces of naphthacene is quite suitable for studying the fluorescence of the latter. By exciting such a crystal by light of various wave-lengths, we have obtained the following results. (1) The positions and the number of the fluorescence bands of naphthacene remain unchanged with the change of wave-length of the exciting radiation. (2) Naphthacene fluoresces so long as the exciting radiation is not of longer wave-length than the longest wave absorption band of naphthacene. Solid anthracene has an absorption band lying at wave-lengths shorter than 400 mμ and fluorescence bands at 403, 422, 438, 445 mμ. Solid naphthacene has absorption bands at 425, 453, 485 mμ. In solid solution of anthracene, there is a red shift of these bands, and in the above crystal we find the absorption bands of naphthacene at 435, 460, 491 mμ. The fluorescence bands of naphthacene are at 498, 533, 574 mμ. They are due to naphthacene, for pure anthracene has no fluorescence bands in this region.

In the crystal mentioned above, naphthacene molecules are found to fluoresce by any radiation equal to, or shorter than, the longest absorption band of naphthacene. Using radiations 460, 475, 490 mμ respectively, we find the naphthacene molecules to fluoresce.

Bowen[1] has suggested that in such a crystal the anthracene molecules absorb light energy, give it to naphthacene and thus it fluoresces. But radiations of wave-lengths 460, 475, 490 mμ cannot be absorbed by anthracene molecules, which do not fluoresce when excited by these radiations. If excited by radiation of wave-length shorter than the longest absorption band of anthracene, both the anthracene

and naphthacene molecules fluoresce. Our experimental results that light of wave-lengths 460, 475, 490 mμ, which cannot be absorbed by anthracene molecules, can produce enhanced fluorescence of naphthacene, is against Bowen's hypothesis.

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[1] Nature, **142**, 1081 (1938).

Mr. Ganguly's observations, which are in complete accord with those of several other workers on the subject[1], can scarcely be said to refute the idea of energy transfers in crystals. Solid naphthacene fluoresces with its characteristic band emission, though rather faintly; when dissolved in solid anthracene it also fluoresces, as Mr. Ganguly notes, if illuminated by light which is directly absorbed by naphthacene molecules (4350–4000 A.). The vital question in the matter of energy transfer is what happens when shorter-wave light is used. If the mercury line at 3650 A. is used for excitation, the green fluorescence of naphthacene is visible in solid solutions containing only one molecule of naphthacene in 10^5 molecules of anthracene; at 1 in 10^4 this green fluorescence is strong, and above about 5 in 10^4 the green is brilliant while the violet anthracene fluorescence has disappeared. At 3650 A. anthracene absorbs much more strongly than naphthacene; the extinction coefficients in liquid solution are 1600 and 400 respectively, so that unless the ratio of extinction coefficients changes by a factor of about 10^4 in passing from solution to solid, the light must be absorbed by the anthracene molecules.

This being so, an explanation must be found for the emission by the naphthacene and the quenching of the anthracene emission. One possibility is that the anthracene emits its fluorescence (4450–4030 A.) and that this is reabsorbed by the naphthacene, the bands of which are in this region. However, the *maximum* extinction coefficient of naphthacene in (liquid) solution is 12,000[2]; this possibility is likely to be effective therefore only at molar ratios of anthracene to naphthacene of $12{,}000/1{,}600 \simeq 10$ (again assuming that the solid absorption ratios are not greatly different from those of liquid solutions). Since the maxima of the naphthacene absorption bands do not overlie the maxima of the anthracene fluorescence bands, this ratio must be an over-estimate, probably by a factor of 10.

We are therefore forced to assume an 'exciton'[3] mechanism. The electronic energy in an excited anthracene molecule must be mobile and capable of moving from molecule to molecule in the crystal by resonance. In pure anthracene the career of the exciton is terminated by fluorescence at some point. When naphthacene is present in solid solution, the exciton is trapped owing to the lower energy level of the excited state of the molecule below that of anthracene; the excess energy is lost as heat, and the fluorescence afterwards emitted is that of the naphthacene. Liquid solutions (as in benzene) of anthracene containing minute amounts of naphthacene fluoresce like pure anthracene instead of the green of naphthacene, the 'handing on' process being inhibited by lack of molecular proximity and orientation. For this reason impurities in crystals in general often profoundly alter the fluorescence properties while exerting no such effect when the whole is dissolved up in a liquid.

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[1] For example, Dufraisse and Horclois, *Bull. Soc. Chim.*, 1888 (1936).
[2] Clar, *Ber.*, **65**, 503 (1932).
[3] Franck and Teller, *J. Chem. Physics*, **6**, 861 (1938).

Reaction Between Solids

In reactions between solids the transport of the reactants through the reaction-product is rate-determining if the formation of the new compound on the surface of the reactants proceeds fast enough. The rate is then closely connected with the mobility of the 'reacting constituents', that is, ions and electrons, in inorganic substances. The behaviour of the reaction product as a semi-conductor is indicative of this mobility.

Experimental verification of recent theories[1] on this subject has nearly all been confined to simple reactions between a metal and a metalloid, such as in the corrosion of metals, and has been mainly carried out at temperatures not much above room temperature.

We have investigated the formation of spinel, $MgAl_2O_4$, from magnesia and α-alumina above 1,000° C. This reaction is probably characteristic of others encountered in the refractory and ceramic industries, and also in the production of many metals from their oxides by reduction with aluminium. Unpublished investigations in this laboratory have shown that spinel is an intermediate compound formed during the production of magnesium vapour by reduction of magnesia by aluminium *in vacuo*.

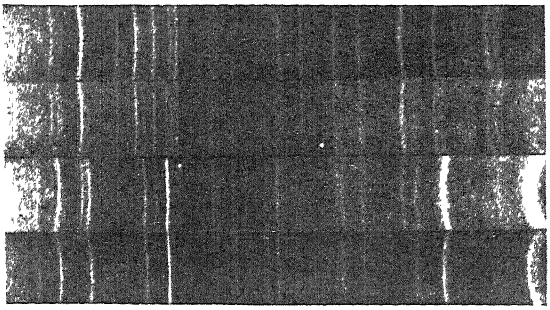
Alumina[2] and magnesia[3] are both 'reduction' semi-conductors[4], that is, substances the conductivity of which increases when heated in a reducing atmosphere (for example, hydrogen) or vacuum. By this treatment they lose oxygen and the excess metal is left behind as positive ions in interstitial positions, electrons being trapped in the ionic field[4]. Very probably the same applies to spinel[5].

If this is so, and if the reaction on the phase boundary proceeds fast enough, spinel should be formed at a higher rate in a reducing atmosphere or *in vacuo* than in air. To check this theory two sets, of four cylindrical briquettes, one inch in diameter and one inch high and each weighing 25 gm., were made up of powdered magnesia and α-alumina (passing 200 mesh, $r \leqq 0 \cdot 037$ mm.) in stoichiometric proportion. The briquetting pressure was 11·4 tons per sq. in. To one set there was added 5 per cent of metallic magnesium powder.

The briquettes containing the magnesium powder (set *a*) were heated to 1,000°, 1,050°, 1,100° and 1,150° C., respectively, in a high-frequency vacuum furnace evacuated to a pressure of 0·1 mm. of mercury and maintained at temperature for one hour. The briquettes of the other set (set *b*) were heated in the same furnace, and under exactly the same conditions of temperature and time as set *a*, but without evacuation of the furnace.

Debye diagrams (copper $K\alpha$) were then made from powder from each briquette and compared qualitatively with those of spinel and the original reaction mixture. In all the magnesium gettered specimens

Low orders High orders



(i) (ii) (iii) (iv)

X-ray powder spectra of the reaction $Al_2O_3 + MgO \rightarrow$ spinel.

	Per cent spinel.
(i) Alumina and magnesia	0
(ii) Alumina and magnesia, baked in air at 1,150° C.	20
(iii) Alumina and magnesia, baked in vacuum at 1,150° C.	65
(iv) Spinel	100

(set *a*), the spinel lines appeared stronger than in the corresponding air-baked ones (set *b*), this fact being perhaps most marked at a reaction temperature of 1,150° C. (see accompanying photograph). Photometer measurements on three lines of these specimens, using a 1 : 1 mixture of spinel and unreacted mixture as standard, showed about 65 per cent spinel in the (*a*) specimen and only about 20 per cent spinel in the air-baked one (*b*).

Using the relation between time and yield for powder reactions, these figures would indicate a more than ten-fold higher 'reaction constant' in the 'reduction' case. Neither the definition of the oxygen pressure and the powder size nor the accuracy of the analysis warrant more than the order of magnitude of this factor to be determined.

We wish to express our gratitude to Mr. W. E. Prytherch, director of research, High Duty Alloys, Ltd., for permission to carry out this work and to publish these results. Our thanks are also due to Prof. P. Gross, who instigated the work and whose advice was available at all times.

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S. DILNOT.
MARY WARRINGTON.

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April 6.

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Age of the Saline Series in the Salt Range of the Punjab

IN his attempt to establish as Eocene the age of the salt of the Salt Range of the Punjab, Prof. B. Sahni[1] has succumbed to the temptation of generalizing too far from a particular instance. In 1925 I discovered fossil evidence indicating a Cambrian age for the Hormuz Series of the Persian Gulf, and in consequence I became an advocate for a similar age for the Saline Series of the Salt Range. Sahni now wishes to reverse this result and to make the Persian Salt Eocene—but the reaction is not reversible. The Persian salt domes occur in an area which is unquestionably autochthonous and, as they intrude rocks of Middle Cretaceous age in some cases, the salt must be of that age or older. Some of the associated rocks brought up by the salt are of a saline facies, with salt pseudomorph sandstones, gypsum, etc., and the fossil control establishes Cambrian, therefore the presumptive evidence is that the salt is also Cambrian. The map accompanying J. V. Harrison's[2] paper shows the breadth of the normally folded zone and the impossibility of assuming any large-scale thrust faulting. Also the Cambrian, where it appears in normal exposure farther to the north-west, has a similar salty facies.

I have not had personal experience of the Salt Range, but from a study of the literature and from conversations with Gee, Lehner and others, I find that the regional evidence is strongly in favour of a Cambrian age for the Salt Marl group. If Sahni's further work establishes beyond all doubt that the land-plant remains really belong to the salt instead of being caught up by it perhaps during the forward thrusting, then the answer may be that there are two salts, one of Cambrian and one of Eocene age. This would be quite an acceptable solution, and its only unpleasant consequence would be that it would bring to an end what has been a very stimulating controversy. In Persia there are thick deposits of Miocene salt, lagunar conditions locally in Oligocene, Eocene, Cretaceous, Jurassic and Triassic, and there is also Cambrian Salt.

There has been a tendency in the past on the part of many geologists to disbelieve in the possibility of salt masses being as old as Cambrian and still preserved, and Sahni is in good company in this respect. I answered similar criticism from Krejci-Graf[3] and Kossmat[4] in 1938[5]. In this connexion, attention might be directed to the extensive Middle Cambrian Salt deposits of Siberia, and also to lagunar developments in Upper Cambrian, Silurian and Devonian[6].

I hope to be able to send Sahni the samples from Persia for which he asks, and shall look forward to his further publication with great interest.

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[1] NATURE, **153**, 462 (1944).
[2] Harrison, J. V., *Quart. J. Geol. Soc.*, **86**, Pt. 4 (1930).
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[6] Vologdin, A. G., and Smirnov, L. P., *Inter. Geol. Congress Abstracts*, 23 (1937).

PROF. B. SAHNI[1] has anticipated me in publishing conclusive evidence regarding the non-Cambrian age of the Saline Series of the Punjab Salt Range.

In connexion with the researches at present being conducted in the Fuel Laboratories of the Imperial College, regarding the nature, composition and origin of kerogen rocks (oil shales and allied materials) of the world, I had the opportunity of examining in detail, during 1941–42, six specimens of kerogen rocks occurring in association with the Saline Series of the Punjab Salt Range and the salt

deposits of the Kohat region. The five specimens from the Salt Range were collected under the supervision of Mr. E. R. Gee, and the Kohat sample was collected by Dr. A. L. Coulson, both of the Geological Survey of India.

The position and occurrences of the six samples, according to the information supplied to Dr. G. W. Himus, Imperial College, by Mr. Gee and Dr. Coulson are as follows: Sample 1 (Warcha Mandi A): from the Lower Saline Series (in the gorge north of Fathepur Maira). Samples 2 and 3 (Warcha Mandi B1 and B2): from the Lower Saline Series (at the junction of Warcha and Jan Sak gorge). Sample 4 (Kalabagh): from the lower gypsum-dolomite stage of the Saline Series (in a tributary half a mile north-west of Kalabagh). Sample 5 (Makrach): bituminous shales, running among the dolomite and gypsum at the top of Saline Series (on the left side of Nawabi Kar, two and a half miles north-west of Makrach). Sample 6 (Kohat): 'oil shale' occurring in the gypsum capping the salt deposits near Kark.

Presumably the 'oil shales' mentioned by Prof. Sahni now being examined by him are similar to samples 1, 2 and 3.

Besides the two theories mentioned by Sahni, namely, (*a*) the Saline Series in the eastern part of the Salt Range is of Lower Cambrian or pre-Cambrian age, and (*b*) the Saline Series is of early Tertiary age, there is a third theory, (*c*), the Saline Series of the Salt Range is of Cambrian or pre-Cambrian age, but the salt deposits of the Kohat region are of Lower Tertiary age.

The question of the Kohat salt was decided by the discovery of fossil fish and Eocene foraminifera in the gypsum capping the rock salt. Thus the age of the Kohat kerogene shale is also Eocene. This means that there are not only two groups of salt deposits in the area, but also two groups of 'oil shales' of similar composition and nature, lying close to each other but of entirely different age. This conclusion on the very face of it appears improbable.

Sir Edwin Pascoe[2] in 1920 said: "That there should be two important salt-bearing groups, each containing hundreds of feet of salt, of entirely different age, the one Lower Cambrian or older and the other Eocene, occurring within 20 miles of each other (and indeed meeting each other near Kalabagh, A.L.), does not commend itself as probable". Fox[3] correlated the Kohat salt with the salt of the Salt Range on grounds of probability and attributed Cambrian age to both of them. Since then the age of the Kohat salt has been decided, but the salt of the Salt Range is still held to be Cambrian or older.

Not having sufficient field knowledge of the area, I raised the matter of the kerogen rocks with Mr. P. Evans of the Burmah Oil Co. (who also previously had produced evidences[4] of the Eocene age of the Saline Series) and in my communication to him I pointed out that the geochemical and petrological (especially the heavy mineral distribution characteristics) evidences indicate that the oil shales from the two areas are of the same age, suggesting Tertiary age of the Saline Series. Evans stated (March 19, 1943) that he thought the Kohat oil shale to be of Tertiary age, and Makrach and Warcha shales, on the grounds of Cambrian theory of the Saline Series, of Cambrian age; but he was not sure about the age of the Kalabagh samples. He thought it was surprising to find two series of oil shales of entirely different ages, occurring so close to each other, but perhaps not so surprising as the existence of two groups of deposits of the salt, and asked me to refer the question to Mr. Gee.

Further examination of the slides of the respective kerogen rocks decided the question. Down and Himus[5] have reported ill-preserved algæ and spores, and macerated plant debris from the Kohat shale. This was confirmed by me. Warcha and Kalabagh specimens, when examined under high magnification, revealed well-stratified and numerous minute fragments of blackened or carbonized and resinified angiospermous wood, fossil microspores and possibly some cuticles and pollen grains, occurring either in the shale matrix or in the dolomitic marl. The Makrach sample revealed numerous fossilized algal colonies, besides macerated plant remains. Owing to the ill-preserved nature of the specimens, it is difficult to determine the genus, but they resemble the algal bodies described from other kerogen rocks. The microstructures contain well-formed minute crystals of calcite, spherular pyrites and sometimes gypsum crystals formed in the cavities.

The identification of the 'yellow bodies' occurring in the kerogen rocks from various parts of the world as algal remains is now well established, since Blackburn and Temperly[6] convincingly proved that these algal remains do not differ in any material respect from the living alga *Botryococcus Braunii*. The nature of the algal remains in sapropelic deposits has been described by various workers, among them Zalessky[7] in Russia, Thiessen[8] and Bradley[9] in America, C. E. Bertrand and Renault[10] and Paul Bertrand[11] in France, and Edgeworth David[12] in Australia.

The nature of the calcite crystals and the pyrite granules is very characteristic in the fossil alga of all the kerogen rocks I have so far examined. This has also been noted by Bradley[9] and others[13].

Fox himself has pointed out that the occurrence of bitumen and oil in rocks of this area indicates Tertiary age of the deposits. Some have tried to ascribe the occurrence of bitumen and oil in the salt to migration of oil from upper horizons; for example, Nummulitic strata. Examination of the kerogen rocks from the Saline Series of the Salt Range and the Kohat area leaves no doubt that these are composed of the 'Ur-materials' of Pascoe, the mother rocks from which the lighter fractions of oil have migrated to other horizons.

Prof. Sahni is to be congratulated for deciding the second greatest controversy of Indian geology in the same manner as he decided the other great controversy, namely, the age of the Deccan Traps.

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April 17.

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Composition of the Bracken Frond throughout its Growing Season

DURING 1942, the variation in the composition of the bracken frond throughout its growing season was investigated in Perthshire at Ballochraggan, the bracken experimental area of the West of Scotland Agricultural College. A uniform 100 yards square area of hill bracken was chosen on typical Scottish upland soil and from it fronds were taken at intervals throughout the season.

At each sampling a hundred fronds were weighed and the dry matter determined. It was noted that the percentage dry matter increased until the beginning of July and thereafter remained constant until September, when it again increased. It is interesting to note that the date on which the percentage dry matter became constant is approximately that regarded as most suitable for eradication by cutting.

The percentages of nitrogen, phosphorus, potassium, calcium and magnesium were determined in the dry matter and several points were observed.

The percentage of potassium (expressed as oxide) in the dry matter ranged from 5·60 in May to 0·86 in October, which emphasizes the recognized power of bracken to accumulate this element in the frond. It is debatable whether this high concentration is absolutely necessary for the normal metabolism of bracken, but if it is, then the problem of bracken eradication might be further explored by investigating the potassium absorption mechanism of the plant.

Throughout the season the percentages of nitrogen, phosphorus, potassium and magnesium in the dry matter progressively declined, the rate of fall being greater in the early stages. The percentage of potassium decreased considerably more rapidly than the others. On the other hand, the percentage calcium in the dry matter increased steadily until September, after which it decreased slightly, a condition often found in the leaves of plants.

The actual weights of certain elements in a hundred fronds were calculated for each sample, and it was noted that the maximum amounts of dry matter, nitrogen, phosphorus, potassium and magnesium occurred in the fronds about the beginning of August, whereas the maximum calcium did not occur until September. The amounts of dry matter, magnesium and calcium which were lost from the frond at the end of the season were relatively small, being 15·2 per cent of the dry matter, 24·0 per cent of the MgO and 11·9 per cent of the CaO. Conversely, the percentages of nitrogen, phosphorus and potassium lost were relatively great, being 72·8 per cent of the nitrogen, 77·8 per cent of the P_2O_5 and 63·2 per cent of the K_2O. The probable migration of nitrogen, phosphorus and potassium from, and the retention of the calcium and magnesium in, the ageing leaf are in accordance with the general views on such matters.

The rates of absorption are interesting. More than 70 per cent of the phosphorus was taken up before the second week of June, while less than 15 per cent of the calcium was absorbed in the same period. Between 30 and 50 per cent of the nitrogen, potassium and magnesium were absorbed during that time. Some authors have suggested that phosphorus is associated with intense meristematic activity, and the early absorption of P_2O_5 by bracken may be further evidence for this.

When the ratios of the amounts of certain elements absorbed by a hundred fronds at successive stages of growth were compared, it appeared that the only ratio which tended to be constant was the N/K_2O. This relationship has been observed in some other plants and suggests that nitrogen and potassium compounds may be closely associated in the metabolism of the frond.

It is intended to carry this investigation further in 1944 by examining and comparing the composition of rhizomes and fronds throughout the season. This should supply information about the movement of nutrients into the plant from the soil and their distribution between rhizome and frond. It is also hoped to study on similar lines the nutrition of poorly developed bracken and to correlate this with factors of the environment. At the same time the importance of information on the general biochemistry of bracken, about which surprisingly little is known, will be borne in mind.

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The Ishihara Test for Colour Blindness

Vernon and Straker[1] claim that 5·37–9·45 per cent of colour blind men were found in Great Britain, according to district, averaging 7·49 per cent. This is about twice the accepted figure. They suggest the difference is due to use of "a modified form" of the Stilling and Ishihara Tests, which "picks out many of the colour-weak, or anomalous trichromats, as well as the strictly colour-blind".

In my investigation[2], 87 subjects tested with the Rayleigh equation were given the Ishihara Test (8th edition, 1939). They were 14 red-green blind men, 4 red-green blind women, 2 green anomalous men, 13 red-green weak men and 18 red-green weak women, 9 normal men and 27 normal women. The red-green weak have two to four times, and the colour blind five to twenty-one times the modal threshold for distinguishing the red-green variable disk from the standard yellow. The anomalous have a small threshold but a big deviation ($> 3\sigma$); the colour blind a very big threshold but usually a small deviation (whether protanopes or deuteranopes). The anomalous are not true intermediates between colour weak and colour blind[3]. Houstoun's[4] view is confirmed that the colour blind form a separate group in the population, because only 2 per cent of the men or women other than colour blind have more than three times, and only 2 of the 18 colour blind less than six times the modal red-green threshold, while true intermediates were not found.

The accompanying table shows that in the Ishihara Test no colour blind or anomalous subject in this experiment gave more than one reading unequivocally correct in twenty-four plates (the first of the twenty-five plates is always correct and only used to show the subject what to do). Four protanopes were not distinguished from deuteranopes by the test, nor two deuteranopes from protanopes. Moderately colour blind were not consistently distinguished from extreme, nor anomalous from colour blind, and this has been confirmed later with red anomalous, though some lesser deviants make fewer mistakes.

		Frequency of: Correct readings	Double readings	Errors
Extreme C.B	Prot. (3 ♂, 0 ♀)	1–2	0–1	23–24
	Deut. (3 ♂, 1 ♀)	1–2	0–2	22–24
Moderate C.B.	Prot. (3 ♂, 2 ♀)	1–2	1–5	18–22
	Deut. (5 ♂, 1 ♀)	1–2	3–6	17–21
Green anomalous. (2 ♂)		2	2–8	15–21
R-G- Weak (13 ♂, 18 ♀)	Mode	22	0	0
	Scatter	14–25	0–7	0–8
Normals (9 ♂, 27 ♀)	Mode	21	0	0
	Scatter	14–25	0–8	0–9

On a level of failure of nineteen or less correct in twenty-four plates, the Ishihara Test would have failed 9 of the 31 red-green weak subjects, but not consistently the weakest, and 9 of the 36 normals. Proportions of correct, alternative and 'blank' readings gave no accurate information about degree of weakness, though the test was used in a very strict manner.

Some red-green weak subjects might be dangerous and ought to be failed. The Ishihara Test is not capable of picking them out accurately. A warning to almost the same effect is given in the introduction to Stilling's Tables (17th edition, 1926).

The Ishihara Test is unsatisfactory as a scientific instrument[5]. It also errs on the side of severity, a good fault, but in an undiscriminating way, which is unfortunate, and Vernon and Straker's percentages may be unduly high.

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Incidence of Colour-Vision Weakness

Vernon and Straker[1] reported that the incidence of colour-vision defect among recruits for the Royal Navy was least in the north-eastern part of Britain and greatest in the south-western part. They deduced that colour-vision defect may be racially connected with pigmentation.

The colour-vision of the first-year medical students at the University of Glasgow, who represent an educated cross-section of nearly all of the mixture of races in the west of Scotland, was examined with a set of Ishihara cards. Ten men were found colour-defective, out of 138 tested, an incidence of about 7 per cent. The colours of hair and eyes, and the general build, were noted. Five had hair of shades of brown; all five had blue or blue-grey eyes; one was very tall, three were stocky, and one was small and thin. One with black hair had brown eyes and was fairly tall; one with dark hair had hazel eyes and was small and thin. Three with fair hair had blue eyes and were of short stature.

The number is small, but the absence of any association of pigmentation or of physical type with colour-vision defect suggests that other possible causes of Vernon and Straker's interesting results should also be considered. For example, there may be some selection made by the men themselves, especially in the more educated groups, in which the individual who knows that his colour-vision is defective will tend to avoid presenting himself for the Royal Navy. Tests on army cadets at Glasgow have shown an incidence of colour-vision weakness higher than normal; this was found to be caused by the presence of several men who, but for their known colour-vision weakness, would have volunteered for the Royal Navy or the Royal Air Force.

The statistical surveys by Waaler[2] and von Planta[3] cannot be ignored. Waaler at Oslo examined 9,049 boys and 9,072 girls; von Planta at Basel examined 2,000 boys and 3,000 girls. The races are very different, yet the results are in agreement not merely in overall incidence but also in the incidence of each of the two defects, deuteranomaly (including deuteranopy) and protanomaly (including protanopy):

Incidence of colour-vision weakness.

	Males			Females		
	Deuter-anomaly	Prot-anomaly	Total	Deuter-anomaly	Prot-anomaly	Total
Waaler	6·10%	1·91%	8·01%	0·41%	0·03%	0·44%
v. Planta	5·75	2·20	7·95	0·33	0·10	0·43

These results indicate that the incidence of colour-vision weakness in Europe is probably independent of race, and that deuteranomaly and protanomaly are different colour-vision defects, inherited independently. That these two independent defects exist may be the reason[4] why the incidence of colour-vision weakness in females is 0·44 per cent, instead of 0·64 per cent as required by a simple theory of the inheritance of one sex-linked factor; the missing 0·20 per cent represents women of pseudonormal colour-vision, who have inherited both defects.

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April 15.

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Road Safety and Road Structure

In his comments on my article "Road Safety and Road Structure" in Nature of May 20, p. 623, Lieut.-Colonel O'Gorman refers to the use I made of statistics in discussing the road accident problem.

Lest the reader is inclined to place undue emphasis on the secondary effects to which Colonel O'Gorman quite rightly refers, it should be pointed out that the sole purpose of the reference to statistics in the early part of the article was to support the conclusion that, "unless novel methods of prevention were introduced", there would probably be a serious increase in road accidents when traffic took to the highway again after the War.

As this is largely the foundation of Colonel O'Gorman's own praiseworthy efforts to get road accidents studied scientifically, I have felt it desirable to clarify the point.

W. W. Davies.

COLD DENSE MATTER

FOR his presidential address to the Section of Physics at the thirty-first Indian Science Congress, held at Delhi in January, Dr. D. S. Kothari took as his subject "Cold Dense Matter". Here the word 'cold' is used in a technical sense as meaning that any free electrons present constitute a degenerate gas—the actual temperatures can range from planetary temperatures to those of the interiors of white dwarf stars. Dr. Kothari's address has now been published, and it gives us a welcome summary of the main features of temperature- and pressure-ionization of matter at high and low temperatures and at high and low densities.

The thermodynamic theory of ionization in gases, though first used in particular applications by Lindemann (now Lord Cherwell), was given its dominating importance in astrophysics by the work of Saha. Saha showed that the dissociation of atoms into ions and electrons is encouraged by reduction of pressure or increase of temperature. But, as Kothari points out, pressure variations are comparatively unimportant in influencing the degree of ionization unless the temperature is of a certain order of magnitude given by the relevant ionization potential; for temperatures much lower or much higher, ionization will be either negligible or complete, whatever the pressure, and we therefore rightly describe Saha's ionization theory as the theory of temperature or *thermal* ionization. In his address, Kothari proceeds to discuss in some detail another kind of ionization, which he calls *pressure* ionization. This occurs in the case of relatively cold matter at high densities, when the atoms are pressed so tightly together that there is room neither for the outer electrons to be in bound orbits nor for them to be associated with particular ions. Kothari sums up the differences between thermal and pressure ionization in three compact propositions:

(i) Thermal ionization occurs in hot or non-degenerate matter; pressure ionization in cold or degenerate matter.

(ii) If, keeping temperature constant, the density be reduced, then the degree of ionization is increased for thermal ionization, and decreased for pressure ionization.

(iii) If, keeping density constant, the temperature be increased, the degree of ionization is increased in thermal ionization but remains practically unaffected in pressure ionization—unless the increase in temperature is so large that degeneracy is removed and pressure ionization passes into thermal ionization.

The discovery by Fermi and Dirac in 1926 of the correct form of quantum statistics to apply to gases had its repercussions on ionization theory: the early simple formulæ require modifications at large densities and low temperatures, where there sets in a 'degeneracy' which we have already mentioned. In addition, at very high temperatures further modifications are required, due to the need to use Einstein's modifications of Newtonian dynamics when the kinetic energy of thermal motion becomes comparable with the rest energy due to mass. The early part of Kothari's address contains a useful complete summary of the various discriminants which determine the different cases that arise at high or low densities or temperatures.

The later portions of his address are chiefly concerned with the applications of these general principles to the particular circumstances of the white dwarf stars and the planets. White dwarf stars were first recognized as configurations with degenerate cores by Sir Ralph Fowler. This theory has been considerably developed by Stoner and Chandrasekhar, and in his address Kothari rounds off these investigations, showing *inter alia* what had previously been assumed outright, namely, that for white dwarfs of mass exceeding a certain small critical mass, the stellar material is completely ionized. The application of the theory to bodies of planetary mass is a piece of original work of great beauty, due to Kothari himself. He shows that if we consider a series of 'cold' bodies of increasing mass, the radius increases to a maximum for a mass about one thousandth of that of the sun, and thereafter decreases; the physical reason is that ultimately increase of mass so increases the central pressure that the atoms suffer such a degree of pressure ionization that they finally occupy a smaller total volume in spite of the increased mass. The value of the radius at the maximum is shown by Kothari to depend to some extent on the chemical composition of the material, and he infers that the observed mass/radius values for Jupiter and Saturn are consistent with their being formed largely of (dense) hydrogen, whereas the terrestrial planets (Mercury to Mars) lie nearer the iron curve. The address concludes with a closely reasoned account of the probable evolutionary history of a body of planetary mass, together with Kothari's own difficulties with his theory.

E. A. MILNE.

MEDICAL EDUCATION IN INDIA

FOR his presidential address to the Section of Medical and Veterinary Sciences at the thirty-first Indian Science Congress held at Delhi in January, Dr. K. V. Krishnan chose "Medical Education" as his subject. Progressive medical educationists in India are not, he said, satisfied with the existing medical educational institutions, and wish to reorganize them in the light of recent trends of Western medical thought. It is now more than a hundred years since the first medical college was established in India and it is time for a stock-taking. India and the U.S.S.R. are the only two countries in the world which still have a dual standard of medical education, and both have decided to abolish it. The U.S.S.R. has already done much to abolish the lower standard. Madras and the United Provinces have already abolished it. Elsewhere in India there are still the medical schools which turn out licentiates with a lower standard of education and the colleges which produce university graduates. In the very near future, Dr. Krishnan hopes, there will be only the medical colleges.

Most of these colleges are not, however, planned according to the principles laid down by Flexner in his "The Idea of a Modern University". India is still producing the "tradesman doctor"; and should go on, as Britain, the United States and the U.S.S.R. have done, to the production of medical men whose ideals are the service of the public, the prevention of disease and the maintenance of health, rather than the cure of illness after it has been allowed to develop.

In the course of his address, Dr. Krishnan makes valuable suggestions for improvements along these lines. The libraries of the medical colleges should be extended and provided with foreign periodicals, text-books should be produced which deal with Indian

problems of health, men with the scientific bent of mind should be attracted to medicine and should be given better facilities for research. Clinical teaching should be improved by the provision of more beds per student and of teachers who emphasize the art of medicine and correct the tendency of students to depend too much on laboratory aids to diagnosis. More Indians should be given opportunities to become deans of medical colleges, and all teaching staff should be debarred from private practice. The teaching staff should, indeed, be specially chosen for the work and should find in it all the elements of an attractive profession. Improvement in the hygiene departments is also needed, and every medical college in a country where two-thirds of the deaths are due to bacteria should have a separate department of microbiology. Qualified men should all spend postgraduate time in hospital work and should also have the opportunity of doing postgraduate laboratory work. There should be adequate schemes for the training of specialists, refresher courses for general practitioners and others and courses in tropical medicine.

Discussing the supply of medical students, Dr. Krishnan finds that very few of them at present choose medicine as a profession for humanitarian reasons. India has not nearly enough medical practitioners. On the basis of 1 for every 1,000 people, which is the standard aimed at in Western countries, India should have at least 400,000, which is ten times the number that she actually has at the moment. It will be a long time before the number of colleges can be increased sufficiently to correct this deficit. Dr. Krishnan advocates instead a system of training medical students in batches or shifts—a system by means of which the U.S.S.R. is increasing the number of medical men without, he says, reducing the standard of education. The Leningrad medical school, he states, is said to train four batches of medical students at one time by a system of shifts "as in a factory", and he would like to see a serious trial of this mass-production of medical men in India. It is not easy to understand how such a system is compatible with Dr. Krishnan's other and excellent ideal of emphasizing the art of medicine.

Two outstanding needs of India are dealt with in some detail, the need for more women practitioners and the need for medical men in the rural areas. India has an even greater need for women than the U.S.S.R., where almost 50 per cent of the practitioners are women. But it is the need for rural medical men that Dr. Krishnan emphasizes. There are 388 million people in India and 95 per cent of them live in rural areas. "Intellectually, financially, physically and physiologically the villager may be said to be 'down and out'." In all rural areas are found the witch doctor, the quack, the *ayurvedic* and *unani* doctors and the allopaths. Everyone agrees that the witch doctor and the quack should be stamped out. Some think that the *ayurvedic* and *unani* systems should be retained, but Dr. Krishnan is among those who would abolish these also. India must make up her mind whether to abolish the allopaths as well. Most of her 42,000 existing qualified medical men are in the towns, which have enough doctors. For the rural areas the urgent need is a band of workers qualified in both medicine and public health, who have had also a training in rural problems and psychology. These men should be specially chosen for their desire to tackle the special job of attending to rural needs, to endure its almost continuous hardships and to go to the country people as friends and not as exploiters of their lot. They should be paid a fixed salary by the Government, with free quarters, and should agree to serve for ten years. Dr. Krishnan does not think there would be any difficulty in finding enough men of the right kind for this beneficent work.

Throughout his address, Dr. Krishnan refers to the interdependence of health control and social and economic problems, and thus alligns himself with progressive medical opinion everywhere. It is evident that, if he were an Indian medical student to-day, he would be found among the 5 per cent whom he mentions who chose the medical profession, not because it pays well, but because it offers a chance of serving their fellow men. His ideals are clearly those of the progressive social medicine advocated by Prof. J. Ryle (*Brit. Med. J.*, Nov. 20, 1943, p. 633) and other recent contributors to the *Lancet* and the *British Medical Journal*. These can perhaps be summed up in Ryle's statement that social medicine is "a logical development from and a direct expansion of clinical medicine, of medicine construed in its best Hippocratic sense and activated by the highest Hippocratic ideal; for 'where there is the love of man there also is the love of the Art' ".

Let us hope that the Government of India will, like the Government of Great Britain, take heed of the sufferings of the humble as well as of the great, and see that India gets the medical men and women whom she needs. If the princes and rajahs and merchants contribute to its finance, as Dr. Krishnan invites them to do, they will live in the future with Rockefeller, Nuffield and all the others whose gifts have led so swiftly and directly to incalculable relief of human suffering. G. Lapage.

THE BLACK REDSTART: A NEW BRITISH BREEDING BIRD

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Extraordinarily little is known of the process of extension and contraction of range which many animal species periodically undergo. Among British birds, the only two the extension of range of which during the past hundred years has been at all adequately described are the little owl (*Athene noctua vidalii*)[1], an introduced species, and the fulmar petrel (*Fulmarus g. glacialis*)[2].

An opportunity now presents itself to make a year-by-year study of a bird species, the black redstart (*Phœnicurus ochrurus gibraltariensis*), which is evidently at the beginning of the process of colonizing the British Isles, or at any rate their south-eastern corner. The black redstart was not known to breed anywhere in the British Isles before 1923, and has only quite recently begun to spread away from the southern coastline, where it secured its first foothold. In the summer of 1943, black redstarts were present in eleven English counties, five of which held at least ten breeding pairs[3]. It seems probable that but for the restrictions placed on observation by the War, many more breeding pairs would have been discovered.

The first breeding record for the black redstart in the British Isles was in Sussex, where a pair nested in maritime cliffs in 1923 and 1924, and probably

two pairs in 1925[4]. In 1932 a male bird was thought to be breeding in a maritime cliff in the south of England, possibly the same as the original locality[5]. The second locality where the black redstart has been proved to breed in England has only quite recently come to light. It is now known that three pairs of black redstarts nested in the Palace of Engineering at Wembley, Middlesex, in every year from 1926 until 1941, after which apparently increasing disturbance due to the War drove them away[6]. A fourth pair also nested in the same building in 1937. The next extension of range took place in the south-west, where the species has always been common as a winter visitor. Possibly from 1927, certainly from 1929, "a couple or so" of pairs of black redstarts nested annually on the cliffs of Cornwall[7,8]. The first wave of colonization was completed by pairs which nested in Kent in 1930[9] and in Woolwich Arsenal, London, in 1933[10].

The second wave of colonization, which has continued with gathering pace until the present, began with a pair that nested in Cambridge probably in 1936 and certainly from 1937 onwards[11]. In 1939 a pair bred in Ipswich, Suffolk, and birds were seen in the town in each subsequent year to 1942[12,13]. In 1940 occurred the first breeding record for Inner London, when a pair nested in the precincts of Westminster Abbey, and returned to breed in 1941[14]. This followed a period of increasing frequency of advance guards of non-breeding birds (cf. the fulmar[2]): two in 1927[15], two in 1936[16], one in 1938[17], two in 1939[18], six in 1940[19], and three in 1941[20]. At the same time, a tendency to spread into the suburbs also began: one was heard at the White City, Shepherd's Bush, in 1940[19], and in 1941 a pair nested at Wandsworth and males were seen at Hayes and Hillingdon, Middlesex[20]. In 1940 also nesting was first recorded in the Lower Medway valley, Kent, where it seems to have gone on ever since[21].

In 1942 the species seemed to take a big leap forward[22]. Breeding was proved in London (City, Notting Hill, Wandsworth), Cambridge, Whitstable, Kent, and Burlescombe, East Devon. Non-breeding birds were also present in London (more than twenty), Cambridge, Ely, Lowestoft (also in 1941), St. Leonards-on-Sea, Maidstone, Southampton, Plymouth (also in 1941), and even so far north as Sheffield. Altogether, forty-five to fifty non-breeding males were reported from various parts of England in addition to the six pairs proved to have bred. This compares with seven breeding pairs and nine non-breeding males in 1941. The advance of 1942 was maintained in 1943, when the species bred at St. Leonards-on-Sea, Hastings, Dover, the Medway valley, City of London (three pairs), Lowestoft, and Birmingham[3]. Non-breeding birds were present in Southampton, Dover, London, several Greater London suburbs, and Cambridge. The totals for 1943 were ten breeding pairs and twenty-six non-breeding males.

It is most desirable that every effort should be made to chronicle the further spread of the black redstart in 1944 and subsequent years. The British Trust for Ornithology has agreed to sponsor an inquiry, and all records for this and former years that have not been published should be sent to me at 39 South Grove House, Highgate, N.6. A point on which information is especially desired is the plumage of singing males, as it is known that in many cases these are immature and lacking the white wing-patch of the full adult plumage.

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PETROLEUM REFINING AS A CHEMICAL INDUSTRY

IN an address delivered to a joint meeting of the Society of Chemical Industry (Manchester Section) and of the Institute of Petroleum (Northern Branch) on February 4, Dr. F. Kind outlined the way in which it has become possible for petroleum refiners to adjust production to market requirements, irrespective of raw material. The average crude oil contains 20–25 per cent of hydrocarbons suitable for motor spirit. Invention and development of the chemical cracking process has increased the potential yield to 50–70 per cent of the crude oil. In fact it has furnished a means of adjusting production of motor spirit and gas oil, kerosene and fuel oil from any given crude to meet demands. Similarly, development of the process of solvent extraction has made possible adjustment of chemical composition to market requirements.

Quite apart from being the most convenient source for production of all types of liquid fuel, lubricating oil and asphalt, crude oil is by far the largest and cheapest source of hydrocarbons accessible to man. Until recently, however, little use has been made of petroleum as a raw material for chemical purposes, the reason being that the chemical industry needs pure basic materials for syntheses and processes, and it is exceedingly difficult to obtain pure hydrocarbons from petroleum. With the development of cracking and reforming operations, however, a valuable source of pure hydrocarbons became available. The tail gas formed during these processes contains olefins in recoverable quantities, and it is possible to obtain comparatively large amounts of hydrocarbons with two to five carbon atoms, to separate *iso*paraffins from normal paraffins and olefins from paraffins. It is suggested that, using these individual hydrocarbons as raw material, it should be possible to build up higher hydrocarbons of known chemical constitution and in much purer form than that in which they could be obtained from crude oil. Further, it should be possible to build up hydrocarbons with certain desirable properties which are not present at

all in the original crude oil, or only in insignificant quantities. Already, vast quantities of hydrocarbons are being utilized in the production of synthesized aviation spirits and synthetic rubber. Other olefins, mainly ethylene, propylene and amylene, are being employed on a vast industrial scale, also to a lesser extent the paraffins. It may well be in the future that petroleum will be used more and more as a raw material for synthesizing special hydrocarbons, and that petroleum refining may turn more and more into a chemical industry.

In extension of a view held for many years that centres of consumption rather than oilfields are the right location for modern refineries, Dr. Kind advocates their development in Great Britain. They should be adapted to meet the special conditions prevailing and not necessarily modelled on American or Russian plants. Moreover, once established, the petroleum refining industry should refrain from entering the field of chemical industry proper. Two great industries are envisaged, one producing basic raw materials from petroleum, and the other manufacturing solvents, plastics, fibres, etc., from hydrocarbon 'bricks'. Establishment of these industries will not be an easy task, but there are, in Dr. Kind's opinion, few enterprises which offer such a rich reward for endeavour.

THE PERIDINIALES

DURING the cruise of the non-magnetic ship *Carnegie* of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington in 1928–29 intensive studies were carried out in the Pacific and North Atlantic Oceans, and, combined with the primary oceanographic investigations, a study was made of the plankton. The simultaneous collecting of samples and taking of hydrographic data afforded exceptional opportunities to study the relations between pelagic organisms and their environment. Among the organisms H. W. Graham selected for special study the difficult group of the Peridiniales, and from a preliminary survey it became evident that no general floristic study was possible in the light of the inadequate knowledge of the group. The peridinian life-histories are incompletely known, so that classification rests upon morphology of the cell, and especially upon the number and arrangement of the complex series of skeletal plates. On this basis, so far as it is known, Lindemann has described a number of genera, which have been utilized as a basis for the present study*. For description of the plate pattern, Kofoid's terminology has been used, though for the plate formulæ abbreviations of the plate names have been found simpler in practice than Kofoid's prime signs. The analysis involves special technique which lies mainly in fixation in formalin, separation of the thecal plates by hypochlorite treatment, and orientation and microdissection in glycerine jelly.

For intensive study representatives of five families of Peridiniales have been selected, with the following main objects in mind: to establish standards for analysis, to acquire a more detailed knowledge of the skeletal structure, to study the variation and to gain some concept of the inter-relationships of the genera and species. Besides the general plate features of the cell, Graham has found the number and arrangement of the plates of the ventral area particularly valuable for distinction of genera, and he illustrates the use of this area, the girdle and the hypotheca for this purpose. Owing to the preliminary establishment of genera on incomplete data as to cell construction, it is obvious that the genera and species of earlier classifications are bound to be considerably modified as study of the group proceeds.

The general discussion of the basis for classification and possible relationships of the genera is followed by a systematic description of the types analysed. The monogeneric family Ceratocoryaceæ receives full treatment, and the more difficult section, including Peridinium with its numerous species and variable forms, is studied with special reference to variability. The illustrations are very clear and well reproduced. There are also extensive tables of data bearing on distribution and environment.

Some of the forms, especially the relatively common *Ceratocorys horrida* and *Goniodoma polyedricum*, have proved valuable in tracing movements of oceanic water masses, as their distribution is closely correlated with temperature, so that records of negative occurrence are of significance.

* Department of Terrestrial Magnetism. Scientific Results of Cruise VII of the *Carnegie* during 1928–1929 under Command of Captain J. P. Ault. Biology, 3: Studies in the Morphology, Taxonomy and Ecology of the Peridiniales. By Herbert W. Graham. (Publication 542.) Pp. vii+129. (Washington, D.C.: Carnegie Institution, 1942.) 1.50 dollars.

SPECIFIC DIFFERENCES IN PETUNIA

THREE papers by K. Mather, A. J. Bateman and K. Mather, and P. M. J. Edwards, respectively (*J. Genetics*, 45, 215; 1944), deal with hybrids between *Petunia axillaris* and *P. violacea*. Important conclusions are made regarding the evolution of several characters.

In the first paper, K. Mather shows that *P. axillaris* is self-compatible and that *P. violacea* is a self-incompatible species. Hybridization of the two species shows that the factors $SaSa$ of *P. axillaris* do not inhibit the growth of pollen containing Sa, but the F_1 hybrids are of two types, self-incompatible S_1S_a and self-compatible S_2S_a. When such plants were crossed with *P. violacea*, seed was obtained, but the reciprocal cross was infertile. Similarly, the back-cross to *P. axillaris* gives different results in reciprocal crosses.

Mather suggests that modifying factors (polygenes) influence the expression of the main S allelomorphs. Within the species, the mechanism is stabilized and strengthened by selection of polygenes. When out-crosses are made, this polygenic background is altered. On this view the evolution of the incompatibility mechanism takes place slowly by the selection of those polygenes which favour the intensity of the mechanism.

A. J. Bateman provides further evidence that the S_1S_2 factors of *P. violacea* have a weaker effect in individuals with hybrid constitution. In the light of recent work on cytoplasmic influences, the discovery that pollen containing S_1 is mutually affected by previous association with Sa requires further investigation.

K. Mather and P. M. J. Edwards consider the inheritance of flower-colour in the above hybrids. They show that there are two main colour genes, Ww and Mm. *P. axillaris* contains $wwMM$ and *P. violacea* contains $WWmm$. The succeeding generations range greatly in colour, which is shown by the

authors to be due to the changed polygene complex; in one case a recessive and a heterozygote were the same white colour in the species hybrid. The authors discuss the effect of selection of polygenes upon inbreeding and outbreeding, genetic isolation and the evolution of species. They contend that the constant effect of natural selection of polygenes plays a large part in retaining the stability of the species and the vital constants of the species.

FORTHCOMING EVENTS

Tuesday, May 30

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Mr. E. R. Davies will read a paper by Dr. L. A. Jones: "Psychophysics and Photography".

Wednesday, May 31

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London W.C.2), at 1.45 p.m.—Dr. R. W. Holland: "Education To-day and To-morrow", 10: Lecture summing up the Series.

Thursday, June 1

SOCIETY OF CHEMICAL INDUSTRY (AGRICULTURE GROUP) (at the Institution of Chemical Engineers, 56 Victoria Street, London, S.W.1), at 3 p.m.—Annual Meeting.

Friday, June 2

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Sir Jack Drummond, F.R.S.: "The Hot Springs Conference and its Bearing on Nutrition in Great Britain".

GEOLOGISTS' ASSOCIATION (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. W. R. Jones: "Strategic Minerals".

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Capt. J. Morris: "Coupled Engine Torsional and Propeller Flexural Vibrations", followed by Informal Discussion on "Methods of Investigation of Engine Vibration".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AREA REPRESENTATIVE (male or female) in each of the following centres: Birmingham, Cambridge, Cardiff, Exeter, Leeds, Leicester, London, Manchester, Newcastle and Reading—The Medical Adviser and Secretary, Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1 (May 31).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN CHEMISTRY—The Principal, Royal Holloway College, Englefield Green, Surrey (May 31).

PSYCHIATRIC SOCIAL WORKER—The School Medical Officer, Shire Hall, Nottingham (May 31).

HONOURS GRADUATE to teach MATHEMATICS and some PHYSICS, at the Burnley Municipal College—The Director of Education, Education Offices, Burnley (May 31).

GRADUATE MASTER FOR MATHEMATICS AND GENERAL SCIENCE—The Registrar, Loughborough College, Loughborough, Leics. (May 31).

LECTURER (man or woman) IN MATHEMATICS—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (June 1).

SPEECH THERAPIST (temporary)—The Director of Education, Education Offices, 32 Dovecote Street, Stockton-on-Tees (June 2).

ASSISTANT MASTER to teach SCIENCE and MATHEMATICS for the Textile Industry in the Junior Technical School of the Bolton Municipal Technical College—The Director of Education, Education Offices, Nelson Square, Bolton (June 3)

TEACHER (full-time) of Day and Evening Classes in MINING and MINE SURVEYING at the Whitwood Mining and Technical College, Castleford—The Director of Education, Education Offices, Castleford, Yorks. (June 3).

TEACHER (temporary, full-time) OF MATHEMATICS, and a TEACHER (temporary, full-time) OF MATHEMATICS AND MECHANICS—The Principal, Acton Technical College, High Street, Acton, London, W.3 (June 3).

ASSISTANT MASTER (with Graduate or equivalent professional qualifications) to teach MATHEMATICS AND GENERAL SCIENCE at the Scarborough Technical Institute—The Secretary, Education Offices, County Hall, Northallerton (June 3).

ASSISTANT LABORATORY TECHNICIANS trained in histological and hæmatological techniques—The Professor of Pathology, Royal Victoria Infirmary, Newcastle-upon-Tyne (June 5).

HEAD OF THE BUILDING DEPARTMENT, and a TEACHER OF MATHEMATICS (temporary)—The Principal, Technical College, Church Street, Barnsley (June 5).

GRADUATE ASSISTANT MASTER to teach MATHEMATICS AND SCIENCE, particularly CHEMISTRY—The Headmaster, Junior Technical School and Evening Institute, Eastbourne (June 5).

LECTURER (full-time) IN CHEMISTRY AND PHYSICS in the Liverpool Technical College—The Director of Education, 14 Sir Thomas Street, Liverpool (June 5).

LECTURER (man or woman) IN CHEMISTRY—The Principal, Kingston Technical College, Kingston, Surrey (June 5).

LECTURER (full-time) IN CHEMISTRY—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11 (June 5).

LECTURER (male or female) IN ENGLISH and GENERAL SUBJECTS in the R.A.E. Technical School—The Headmaster, R.A.E. Technical School, Farnborough, Hants. (June 6).

ASSISTANT LECTURER AND DEMONSTRATOR IN PHYSIOLOGY—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (June 10).

STAFF LECTURER IN SCIENCE AND HYGIENE—The Principal, Northern Counties Training College of Cookery and Domestic Science, at Tower House, Tweedmouth, Berwick-upon-Tweed (June 10).

CHIEF AGRICULTURAL OFFICER—The Deputy Clerk of the County Council, Shirehall, Shrewsbury, Shropshire (endorsed 'Chief Agricultural Officer') (June 10).

RESEARCH ASSISTANT (temporary) in the FIELD BOTANY DIVISION of the Ministry of Agriculture of Northern Ireland—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2474A) (June 10).

LECTURER (temporary, full-time) IN PHYSICS—The Director of Education, The Polytechnic, 309 Regent Street, London, W.1 (June 12).

APPRENTICE SUPERVISOR by large Engineering works to supervise educational and training schemes for apprentices and young persons (Nottingham district)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2021XA) (June 14).

PROFESSOR OF BOTANY, ASSISTANT LECTURERS IN ECONOMIC HISTORY, GEOGRAPHY, BOTANY and ZOOLOGY, ORGANIZING TUTOR IN ADULT EDUCATION for Derbyshire, and a TUTOR IN PSYCHOLOGY—The Registrar, University College, Nottingham (June 14).

HENRY MECHAN CHAIR OF PUBLIC HEALTH—The Acting Secretary of University Court, The University, Glasgow (June 15).

LECTURER IN DIETETICS in connexion with Course leading to University of London Academic Post-Graduate Diploma in Dietetics—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (June 17).

METALLURGIST by Firm of Engineers with wide interests (Ph.D., or equivalent, minimum technical qualification)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2286XA) (June 17).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

LECTURER (temporary) IN GEOGRAPHY—The Registrar, The University, Reading.

TWO MEN with experience in, or qualified for training in use of, Podbielniak and other apparatus for the fractional analysis of gases in the laboratory, for service with Petroleum Company in the Middle East—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 878/6).

DIRECTOR OF RESEARCH—The Secretary, British Iron and Steel Federation, Tothill Street, London, S.W.1 (endorsed 'Director of Research').

SECRETARY to the British Iron and Steel Research Association—The Secretary, British Iron and Steel Federation, Tothill Street, London, S.W.1 (endorsed 'Secretary').

ASSISTANT (male) IN BIOCHEMISTRY at the Courtauld Institute of Biochemistry—The Medical School Secretary, Middlesex Hospital, London, W.1.

GRADUATE ASSISTANT (temporary), with special qualifications in MECHANICAL ENGINEERING, a GRADUATE ASSISTANT (temporary) with First or Second Class Honours or Higher Degree in either MATHEMATICS or PHYSICS, and a well-qualified ASSISTANT (temporary) with trade experience for ENGINEERING WORKSHOP PRACTICE—The Principal, Mining and Technical Institute, Neath.

LECTURER IN MECHANICAL ENGINEERING—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 44: Stress-Strain Data for Vulcanised Rubber under various Types of Deformation. By L. R. G. Treloar. Pp. 12. (London: British Rubber Producers' Research Association.) [284

Report of the Rugby School Natural History Society for the Year 1943. (Seventy-seventh issue.) Pp. 36. (Rugby: George Over, Ltd.) [284

Eyesight and Industry. A Speech delivered by the Vice-Chancellor of the University of Oxford at a Mansion House Luncheon on 22 February 1944. Pp. 12. (Oxford: University Press.) [284

Drawing Office Organisation. (Office Aid to the Factory Series.) (B.S. 1100, Part 9, 1944.) Pp. 36. (London: British Standards Institution.) [15

Leicester Museum and Art Gallery. Thirty-ninth Annual Report to the City Council, 1 April 1942 to 31 March 1943. Pp. 16. (Leicester: Museum and Art Gallery.) [15

Board of Education. Teachers and Youth Leaders. Report of the Committee appointed by the President of the Board of Education to consider the Supply, Recruitment and Training of Teachers and Youth Leaders. Pp. 176. (London: H.M. Stationery Office.) 2s. net. [25

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RECRUITMENT AND TRAINING OF TEACHERS

TECHNICAL COLLEGES AND SCHOOLS

FOR many months past the pages of NATURE have referred to the great demands that will be made upon the industrial resources of Great Britain in post-war years and the consequent need for trained technicians and technologists to cope with the gigantic problems involved. Though the general character of the requirements of the situation have been surveyed by a variety of industrial, commercial, professional and educational bodies, it remains largely to the Board of Education to promote and later implement specific proposals for bringing about the necessary improvements in education and training schemes in order to relate them to the practical and social needs of the community in the best possible way. It is therefore gratifying to find that the recent McNair Report* not only gives a courageous and penetrating analysis of present deficiencies in the training of technical teachers (Part III, p. 108) but also advances bold suggestions for tackling what is stated to be "a comparatively new field of enquiry".

The keynote is struck when the report urges that "the standard of technical training which can be offered to those already in, or about to enter, industry, necessarily depends upon an adequate supply of teachers of high capacity and with personal experience of current practice. This fact is basic. Technical teachers, regarded collectively, constitute a key group in industrial development, yet their importance has hitherto been scarcely recognised even by those industries which most directly depend upon them for a supply of trained workers."

As in other fields of education, so in the technical field, greatly increased numbers of teachers will be required to implement the new Education Bill; indeed for the compulsory part-time requirements alone some 2,000–3,000 teachers of the ordinary technical and commercial subjects will be required. To these must be added "some thousands of additional teachers" for the older industries, for example, building, not to speak of the needs of the newer industries such as "plastics and large-scale catering" and many aspects of commerce, for example, marketing and export, which have as yet scarcely been considered. A further most urgent matter is the desirability of lightening the load of the present teachers so that they may be able to carry out research or make essential contacts with industry whereby their teaching may become vitalized and stimulating. These are only a few among the many factors which make it necessary to provide for large increases in the recruitment of technical teachers and render it important to frame schemes of training whereby the recruits may not only become efficient teachers but also be enabled to bring into the lecture room and laboratory a realism which unfortunately is frequently lacking to-day.

Witnesses from the chemical industry told the

*See also NATURE of May 20, p. 601, and May 27, p. 629.

Committee that many teachers of chemistry, in spite of their academic attainments, have insufficient knowledge of industry to adapt their methods to the needs of students; in courses for the building industry many of the higher teaching posts are held by architects who have had little or no experience of practical building and allied trades; textile industrialists often find that even graduates in technology are lacking in the groundwork of the fundamental sciences associated with their work. This latter criticism is also supported by the engineering world. "Commercial" teaching is often of a low order due to the use of antiquated systems and old-fashioned methods of instruction—a state of affairs which is inexcusable in view of the remarkable strides that have taken place in industrial administration in the last twenty years.

Worst of all, it is found that many technical teachers are ill-equipped to teach adolescents, and when it is remembered that, due to the association of junior technical schools with senior colleges, a given teacher under present conditions may have to teach boys of thirteen at one part of the day and lecture to honours degree students at another, it is seen that nothing short of a revolutionary treatment of the whole problem of the training of technical teachers will suffice.

The McNair Committee must be heartily congratulated for facing up honestly to these defects. It is true, of course, that some of the major deficiencies will disappear automatically upon the implementation of the Education Bill. Thus the junior technical school will be recognized for what it is, namely, an aspect of secondary education, and, as such, will come under secondary school regulations. The view that its past success is due to its pupils being taught by the same instructors as for senior students is, on examination, scarcely tenable. The McNair Report, therefore, in discussing the training of technical teachers, recognizes that "The establishment of compulsory part-time education with its vocational studies, and the provision of junior technical and commercial schools as a normal part of secondary education, will change the pattern of technical education and a much larger number of teachers of technical subjects will be required".

Little need be said about the recruitment of technical teachers in the past, for the majority seem to have drifted thither through the force of circumstances, there being no *ad hoc* recruiting ground or training available. Moreover, "the supply of technical subjects teachers ebbed and flowed with the prosperity or decline of industry. Teaching was to some extent a safe refuge from economic storms and, conversely, recruitment declined when teachers were most in demand". What about future recruitment? Clearly, this will depend on making the conditions attractive and laying down a definite policy for higher technical education. It is perhaps in reference to this that the McNair Report reaches the high-water mark of realism, for it bases its recommendations upon the closest collaboration between industry, commerce and technical education. A supply of good and appropriate buildings and equipment, salary scales and opportunities of promotion comparable with those of industry, possibilities of frequent interchange between teaching and industry, not neglecting opportunities for gaining overseas experience and ample facilities for carrying out research, are among the improvements in conditions that are envisaged. "But however many and varied the opportunities for interesting work and experience may be in theory, teachers will not in practice take advantage of them unless the root obstacle is removed. That obstacle is that many teachers in technical and commercial colleges, and especially the more responsible members of the staff, are heavily loaded with teaching duties. They have no time to spare. . . . Some local education authorities or governing bodies impose too narrow an interpretation of what constitutes a full-time appointment."

It must not be assumed that because there will be a great shortage of technical teachers therefore all comers must necessarily be welcomed, for it has to be recognized that teaching is an art and demands a certain aptness and attitude of mind, for even mediocre success. The "elusive qualities of personality" are difficult to describe and assess, but apart from these there are four other qualifications which ideally every teacher should possess, and to these must be added a fifth in the case of the technical teacher, namely, (1) a general education which fits him to be an acceptable teaching member of an educational institution, (2) a high standard of knowledge of his subject, or of skill in his craft, (3) the ability to teach, (4) an appreciation of the relation of his own subject to other realms of knowledge and of his educational institution to society at large and, especially, (5) an intimate acquaintance with his subject in its industrial or commercial setting, if possible through the practical experience of having played a significant part in industry or commerce. The report makes it clear that without a high standard of knowledge of his special subject or skill and an awareness of its industrial or commercial applications, a teacher has no proper place in a technical college. With this we must fully agree. Some good work as a teacher, however, might be done by one who was thus qualified but whose general education was somewhat shaky; this applies only to older persons who by virtue of wisdom and experience in other fields of human interest may be able to give useful teaching service, but for young teachers the full professional equipment is necessary. The point is, however, of importance in connexion with the emergency training schemes for dealing with the great demands for teachers in the immediate post-war years, and may conceivably be considered in connexion with the release of Service personnel, many of whom during the war period have had experience akin to that of teaching, for example, as responsible N.C.O.s or as service instructors.

The above emphasis on the importance of the possession of good technical qualifications does not imply that technical education is concerned wholly with imparting some 'skill', whether mental or practical; on the contrary, the training is only the medium through which a particular attitude to life and the world in general is developed, that is to say,

we must distinguish carefully between 'education' on one hand and 'training' on the other. It is true that the two cannot be entirely separated, but unfortunately it is possible so to stress the training that the educational process becomes of secondary importance, to the great disadvantage of the student. The report does well to emphasize this fundamental matter; indeed, the whole outlook of the report is refreshingly vitalized by its insistence on the *educational* functions of technical colleges. "The good technical teacher is no mere technician; he is also an interpreter of the modern world".

Quite the most inspired section on the training of technical teachers is that dealing with the part which industry must play. It is full of new ideas which, if carried out, will put technical education on a very high plane. Evidence shows that industry is ready and willing to play its part, and war-time contacts between colleges and industry have done not a little towards forging a close bond between the two. The nature of the bond is such that technical education and industry are co-equals. It is not therefore appropriate that the Board of Education should act as prime mover in securing co-operation but rather that the well-established and highly responsible professional institutions should take the initiative as intermediaries. These institutions already possess considerable experience of educational work and include among their members both teachers and acknowledged leaders of industry. They command the respect of all parties and between them cover a large part of the whole field divided up into its natural economic and technological units. Probably the formation of small standing advisory committees would be an effective means of keeping continuously in view the changing situation. The colleges themselves should be so closely linked with local industry that some of the teachers may even be associated with production in all its phases. Large firms might from time to time provide lecture courses and demonstrations in design and manufacturing processes. Experiments on these lines made to date have had remarkable success despite reluctance on the part of some industrialists to encourage the spread of their specialist knowledge. Furthermore, the release by industry of high-grade staff for part-time work in technical colleges would have advantages on both sides and would be of inestimable value to technical education, giving much-needed inspiration from the most powerful source from which the technical teacher can draw. What has been said about co-operation between the factories and the colleges applies equally to co-operation with research associations, which would confer great benefits upon technical teachers by holding refresher courses and visits to their laboratories for selected personnel.

A word must now be said regarding the arrangements for the actual training courses. "There is no generally accepted body of doctrine on the training of technical teachers, nor on the best methods of teaching some of the many subjects to the diverse types of students". The experience gained in Board of Education short courses has naturally been extremely suggestive, but there is still room for much further experiment. The report makes the valuable suggestion that "The time is now ripe for selected technical and commercial colleges and schools in association with teacher-training institutions to experiment . . . systematically and on a comprehensive scale". This training should, however, not be isolated from that of other teachers, and therefore should be undertaken by the area authority recommended elsewhere in the report, which should, for this purpose, include representatives of technical education in its constitution. The major part of the training should be carried out before the teacher begins to practise, for which purpose generous financial provision should be made, and in order to render the scheme flexible so as to deal with the vast range of interests involved, the course should be broken into units of comparatively short duration, for example, (1) education, (2) teaching, (3) study of the 'student', (4) industrial and commercial contacts. By conducting the course in conjunction with technical colleges, the services of experienced teachers would thus be effectively drawn upon and segregation of trainees would be avoided. "A liberal provision of refresher courses to make up for the comparativey short duration of the initial training period" would, of course, be necessary and would at the same time serve to correct any acquired errors of teaching technique and give encouragement to the young trainee.

It will be seen from the above that the McNair Report is a document of the greatest significance to technical education and one carefully calculated to remove the stigma resting upon it at present, namely, that "Technical education in this country has never received the attention it deserves and there has hitherto been no systematic provision for the recruitment or training of technical teachers".

In view of the key importance of technical education in our future national development, immediate steps should therefore be taken to provide the conditions for the implementation of the report at the earliest possible date.

HIGH POLYMERS

High Polymers

By Raymond M. Fuoss, J. Abere, W. O. Baker, Henry Eyring, John D. Ferry, Paul J. Flory, C. S. Fuller, G. Goldfinger, R. A. Harman, Maurice L. Huggins, H. M. Hulbert, H. Mark, H. Naidus, Charles C. Price, John Rehner, Jr., Robert Simha and A. V. Tobolsky. (*Annals of the New York Academy of Sciences*, Vol. 44, Article 4.) Pp. 263–444. (New York: New York Academy of Sciences, 1943.)

IN spite of the difficulty in prosecuting academic work on high polymers during the War, there has almost been a flood of literature, both books and discussions, on this topic. The reason is not far to seek. In the immediate pre-war years the subject was just getting into its stride, and though the rate of progress has naturally been drastically cut down, many workers have been able to make a substantial contribution when an opportunity for discussion has arisen. In the volume under review, the Physics and

Chemistry Sections of the New York Academy of Sciences combined to stage a joint discussion to bring both the chemical and physical aspects of the subject into contact and, it is hoped, alignment. There were eight papers contributed to the meeting, with a general introduction by R. M. Fuoss. Some of the material is new, but the majority of the papers are reviews of published work.

The subject may fairly be divided into two parts; the first dealing with the mechanism of the synthesis of macromolecules, and the second with structure and its connexion with physical properties. The question of reaction mechanism is now fairly well understood in its broad outlines, although there are many absolutely fundamental questions which have hitherto evaded solution. The two main processes of molecular growth comprise: (*a*) those in which each step in the addition of the monomeric unit is kinetically similar, although there may be small changes in the energy of activation and in the temperature-independent factor of the velocity coefficient as molecular size increases; (*b*) those formally similar to the classical chain reactions of kinetics. Generally, it would appear that stepwise growth is confined to poly-condensation reactions. In view of the apparent kinetic simplicity, it might be expected that the study of such reactions would give detailed information as to how velocity coefficients change with molecular size. The unfortunate trouble is that poly-condensations almost invariably occur in very concentrated solutions or between the two components alone, and therefore it is not easy to compute the magnitude of velocity coefficients. However, it is possible to measure the average energy of activation of the reaction and also to measure the distribution of molecular weights about the mean value. By postulating that the velocity coefficient does not depend on molecular size, it is rather interesting to note that the form of the distribution curves may be accounted for. The details of the various calculations are given in the review by Abere, Goldfinger, Mark and Naidus. What is not known with any great certainty is the extent to which the shape of the distribution curve is dependent on a variable velocity coefficient, for at present there is no reliable experimental information as to the nature of such a variation.

By far the greatest part of the experimental and theoretical work has been devoted to those reactions exhibiting chain-like characteristics. The classical chain theory has naturally been of immense value in quickly clearing away the preliminary difficulties, so that a real attack may be made on the problems peculiar to polymerization kinetics. Both the above-mentioned paper and another comprehensive review by Hulbert, Harman, Tabolsky and Eyring deal in some detail with the ideas now fairly well established in this part of the subject. They need not be referred to here. It is perhaps worth while, however, mentioning some of the difficulties. In those reactions where the time for the growth of the polymer is short compared with the half-life of the monomer, the expression for the velocity of reaction contains the three coefficients for starting propagation and termination of growth. The problem is to determine the numerical value of each coefficient. In general, however, we may only observe *two* significant things about the reaction; for example, the velocity and chain-length. One cannot, therefore, obtain the individual values of these coefficients and examine further how such coefficients vary with molecular length. Theoretically, it is possible to calculate the shape of the distribution curve according to various assumptions regarding the mechanism of these reactions and the variation of coefficients with size. The experimental difficulties in getting an accurate measure of the shape of the distribution curve rather restrict this method, so useful in principle, in providing a check on the mechanism inferred, not always unequivocally, from kinetic analysis.

While there is no doubt that in the polymers of vinyl derivatives the growing molecule is a free radical in some cases, as discussed in the article by C. C. Price, there is evidence that other types of active molecule exist. In the paper by Hulbert *et al.*, interesting speculations are made about the nature of the active molecule. With vinyl derivatives, however, it is not yet possible to draw up a summary showing how the velocity coefficient for polymer growth varies with the nature of the group attached to the vinyl group, and thereby probe deeper into the mechanism of polymerization.

The factors that govern the mechanical behaviour of high polymers are as yet only perceived with some difficulty, and no quantitative statements are possible. One method of tackling the problem is to take a given polymer and progressively modify the nature of the side-groups, simultaneously following the changes in physical properties. In this manner Baker and Fuller have prepared a series of polydecamethylene sebacamides using varying proportions of decamethylene diamine and 9-methyl nonamethylene diamine, and have examined the mechanical properties of stretched filaments, with simultaneous observations on structure by X-ray diffraction measurements. The straight-chain polyamide is rather brittle and easily crystallizes, whereas an increasing percentage of methyl groups destroys the regularity of the structure, diminishes the strength of hydrogen bonds and thus reduces lateral attraction between the chains. The 9-methyl polymer therefore exhibits rubber-like properties. Work of this kind serves to demonstrate forcibly that even relatively small changes in molecular architecture may lead to profound changes in mechanical properties. The accumulation of such systematic data will do more than anything else to help in establishing the general principles of a subject full of tremendous possibilities.

The statistical treatment of the theory of rubber elasticity resolved a problem which had seemed insoluble and provided additional support for the ideas concerning the structure of the rubber molecule. That theory initially assumed free rotation round carbon-carbon bonds. Evidence from other sources has accumulated to show that rotation is not free, though the potential barriers may often be as low as a few thousand calories. Florey and Rehner in their contribution to the discussion briefly examine the theory and conclude that the presence of low potential barriers does not lead to any important modification of the theory. They then report on some work from the same point of view on the vexed problem of the constitution of three-dimensional networks. Such polymers are by far the most difficult to investigate, for they cannot be got into solution; they merely swell to a gel, and X-ray methods, because of the impossibility of the existence of a high degree of order, do not yield a great deal of information. Florey and Rehner base their statistical theory on a three-dimensional model consisting of a tetrahedral unit in which four chains originate from the apices

of the tetrahedron and meet in a point—the point of cross-linking—each tetrahedron containing one cross-link. In this way they derive a relationship between Young's modulus and parameters signifying the number of cross-links present in the polymer.

Between the extremes of perfect elastic behaviour, rubber elasticity and the viscous behaviour of a Newtonian liquid, there is a region of behaviour in which a great many high-polymer systems lie. Much effort has gone to try to develop a convincing and all-embracing theory, but it is obvious that the description of the behaviour of a substance which may possess, according to conditions, elements of all three components, is a matter which may well defy solution. It is, however, necessary to systematize data so far as possible, since such polymers are used for a variety of purposes where deformation, especially under the prolonged application of a stress, is a matter of the first importance. Simha and Ferry deal with this aspect of the problem, the former considering particularly the flow of high polymers and the latter very concentrated solutions. There is also an article by Huggins dealing with the thermodynamic properties of high-polymer solutions.

There is, unfortunately, no account of the discussion of the papers presented at the meeting. This does not detract from the interest and usefulness of the volume, but the printed record of a discussion often serves to clarify obscure points and settle conflicting opinions on such a controversial subject.

PROBLEMS OF RACE

Race and Rumors of Race

Challenge to American Crisis. By Howard W. Odum. Pp. x+245. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1943.) 12*s*. net.

THE sins of the fathers are indeed being visited upon the children to the third, fourth and later generations in the southern States of the United States of America. Pressed by an uneasy conscience, the white South has tried here and there to reduce violence, to give somewhat better opportunities of education to the 'Negro', as he is called even if he often obviously has a good deal of white ancestry mixed in. But even those who want to treat the Negroes as brothers do not want them as brothers-in-law, and that is the root of the insoluble conflict. It is evident that recruitment and labour opportunities of the war-economy have given coloured folk a chance to escape from the old-time repression, and that it is becoming more and more difficult, in Africa as well as in the United States, to maintain a society in two layers without letting the lower one up anywhere. Both British and Americans are deeply concerned with the problems involved, and this book pictures for us what happens when the two layers talk about one another. The author gives a collection of fantastic rumours, many of which he helps us to see are quite baseless. But the rumour habit makes even the former limited inter-racial courtesies difficult to maintain; they are made to look like 'treason against your side', and this is inevitably the case, especially among the coloured folk.

The white South wants to be left alone, blames northern journalists, feels it must guard its traditions on behalf of its many brave sons fighting in far parts of the world, and, most of all, its girls whom those sons are likely to marry when they come back. But it cannot be left alone; coloured men in the armies of the United States will not come back to the old limitations. Inevitably the general level of education is still low among the children of the slaves, and the white South wants to protect its social standards and tradition of ease. But social standards are much more difficult to assess than are skin colour and hair type, and the protection of those standards is naturally enough made to include discrimination against, and segregation of, the coloured people. Several States have arrangements which in effect prevent Negroes from voting, and a number have laws making white-black marriages illegal; and Congress in 1944 is much concerned about some of these restrictions. Even were it possible to hand over a portion of the continent to the eleven million coloured people, that would not solve the problem as they would not have experience of either government or management.

The choice in these cases of bifid populations is ultimately between segregation and intermarriage, and segregation has hitherto meant anything but equality of opportunity for the coloured folk. They cannot be held down indefinitely, yet they have neither capital nor administrative experience. Meanwhile, the situation worsens and a world problem of racism on a larger scale than the Nazis talked about looms up, with only minor alleviations in sight.

H. J. FLEURE.

A MEMOIR ON SOME BOLETACEÆ

The Boletaceæ of North Carolina

By Prof. William Chambers Coker and Alma Holland Beers. Pp. viii+96+66 plates. (Chapel Hill, N.C.: University of North Caroline Press; London: Oxford University Press, 1943.) 43*s*. net.

MYCOLOGY is in debt to the University of North Carolina for the monographs which have been published by its press in the past, and now a new one is added to the series. Because of the great range of fungal species, we might expect that a book on the Boletaceæ of North Carolina would be of considerable value to students of these fungi in Britain. However, this purely systematic account will be of little real help to British workers, since of the seventy or so species considered less than a quarter would seem to occur in Britain.

The book is well produced and sixty-seven species of Boletus, four of Boletinus and one of Strobilomyces are considered, twenty-one species being illustrated in colour. There are also photographs of most of the species in fifty-five full-page plates at the end of the book. It is doubtful how much these photographs will help in identification, and they are certainly no substitute for good coloured reproductions.

There are four plates illustrating the spores of all the species considered. A glance at these suggests that only in a very few species does the spore size and form offer much help in making an identification. However, this is a step in the right direction, as progress in the study of the systematics of toadstools lies in paying more attention to microscopic characters. By such attention we may hope that the identification of toadstools will become more of an exact science and less a question of lore handed on by one generation of field mycologists to the next.

C. T. INGOLD.

Minerals in Industry

By W. R. Jones. (Pelican Books, A.123.) Pp. 149. (Harmondsworth and New York: Penguin Books, Ltd., 1944.) 9*d*. net.

THIS War, more than any other, has served, through the agency of the Press and the B.B.C., to bring home to the general public the importance to the belligerents of access to sources of minerals of all kinds. It is no doubt widely realized, too, that the question of mineral supplies will, or should, play an important part in international peace settlements, as well as in post-war trade.

"Minerals in Industry" provides in concise and very readable form all the information on the subject of economically important minerals likely to be required by general readers wishing to take an intelligent interest in such matters. The short introduction includes a brief account of the different modes of occurrence of ores and minerals. There follow, in alphabetical order, descriptions of a very wide variety of mineral substances and metallic ores, with notes on their uses in industry and the arts, together with particulars of the chief producing countries and world output. In a number of cases the average annual output from individual countries for the years immediately preceding the War is indicated diagrammatically; and there are outline world maps at the end of the book showing graphically the location of the sources of many of the more important minerals.

The inquiring reader can also glean from this little book why it is so important that a strict blockade of Germany, a country poor in mineral resources, should be maintained. He can further reconstruct for himself a picture of the disruption to the mineral supplies of Britain that resulted, not only from shipping shortage and submarine activities, but also through the spread of hostilities over Europe and into parts of Asia. How these difficulties have been met and overcome is a story that cannot be told until after the War.

Prof. Jones is to be congratulated on the addition of so excellent a book to the Pelican series.

V. A. EYLES.

The Aborigines—'so-called'—and their Future

By Prof. G. S. Ghurye. (Gokhale Institute of Politics and Economics, Publication No. 11.) Pp. xvi+232. (Poona: Gokhale Institute of Politics and Economics, 1943.) 8 rupees; 16*s*.

PROF. G. S. GHURYE, head of the Department of Sociology in the University of Bombay, here examines the position of primitive tribes in India and the question of their administration. He goes into their position with reference to their classification by the Census of India separately from Hindus and other religious divisions, and into the question of their relationship with Hindus proper; he examines their treatment by the Government of India, and by the British Parliament; he examines the reports, and recommendations, which anthropologists have made in regard to them; and finally he states the problem which, in his opinion, the present condition of the hill and forest tribes presents.

Prof. Ghurye is a whole-hearted supporter of the assimilation of the Backward Tracts to the rest of India politically, and has made the best case he could for this view; though he seems to realize the problem involved in protecting the aboriginal tribesman from the chicanery of Indian money-lenders and land-grabbers, and from the complete unsuitability of proceedings in Indian law courts. He has made himself very thoroughly acquainted with the literature on the subject, but his treatment of authorities does not appear to be entirely disingenuous. Thus he quotes Hutton's statement that the tribesman who claims to be treated as a caste in order to improve his social position frequently succeeds in achieving greater degradation. He goes on to add that Hutton does not attempt to explain why. If he had read to the end of the paragraph he quotes, he would have seen that the explanation given is clear enough; it is that the caste acquired is so often treated as an untouchable one, whereas, so long as the tribesman remains non-Hindu, he is treated with a certain amount of comparative respect. This is an aspect of the problem which Prof. Ghurye has not followed up, though elsewhere he remarks that the Satnami and Kabirpanthi sects are available "for any tribe to take recourse to avoid the stigma of untouchability". Unfortunately, the Chamars and others who belong to those sects are not the less untouchable on that account. Other points on which Prof. Ghurye fails to deal convincingly with his material are his specious argument that infant marriage is preferable to pre-marital license, and his attempt to show that the aboriginal tribes who are on the face of it doubtfully Hindu are quite as much Hindus as many of the lower castes. This may be more or less true in the case of some tribes and some castes, but most certainly does not hold good of all. Prof. Ghurye, wisely for the establishment of his case, avoids dealing specifically with the tribes of Assam, letting their case go with the rest by supposed analogy.

The volume would have been improved by the addition of a proper bibliography of the works quoted, an index, and at least one map.

Dictionary of Organic Compounds

The Constitution and Physical and Chemical Properties of the Principal Carbon Compounds and their Derivatives, together with the Relevant Literature References. Edited by Prof. I. M. Heilbron and H. M. Bunbury. Vol. 2: Eccaine—Myrtillin Chloride. Pp. viii+892. Vol. 3: Naphthacarbazole—Zygadenine. Pp. viii+978. (London: Eyre and Spottiswoode (Publishers), Ltd., 1943.) £6 6*s*. net each vol.

THESE two volumes complete the new edition. As indicated in a recent notice (NATURE, Nov 20, 1943, p. 586), they are reprints of the first edition with supplements containing data collected since the original publication of the work. The supplements comprise 42 pages in vol. 2 and 32 pages in vol. 3. The editors and publishers are to be congratulated on making available under very difficult conditions a new and complete issue of a substantial work of such value in organic chemistry and biochemistry. All practitioners of these rapidly expanding branches of science will hope that here is a dictionary which has come to stay and to keep in step with progress in these vast and complex fields of research. J. R.

The Microbe Man

A Life of Pasteur for Children. By Eleanor Doorly. (Puffin Story Books, P.S.8.) Pp. 112. (Harmondsworth and New York: Penguin Books, Ltd., 1943.) 9*d*. net.

THIS is a short and pleasant account of the highlights in the life of Louis Pasteur, written for children in simple language. The illustrations, woodcuts by Robert Gibbings, are handsome, but irrelevant.

DIAMONDS, NATURAL AND ARTIFICIAL*

By DR. KATHLEEN LONSDALE
Davy Faraday Laboratory, London

MANY people are interested in the diamond on account of its qualities as a jewel, its beauty and durability, or perhaps its value and portability. Others are chiefly concerned with its many industrial uses. To the geologist it is a fascinating mineral; the chemist regards it as the prototype of all the aliphatic compounds. But everyone must recognize it to be the aristocrat of the crystal world and must be interested to know why it attains such a high degree of perfection in so many of its properties. That question cannot yet be given a really adequate answer, for diamond still presents us with a very difficult problem. One point that needs to be emphasized is that each diamond is an individual; diamonds may look alike and yet behave very differently, with the result that it is dangerous, if not actively misleading, to generalize from observations, however accurate in themselves, which have been made on only one, or a few, specimens.

Consider the appearance of diamonds when illuminated by ultra-violet light. Some fluoresce brightly, others scarcely at all; with some the main fluorescence is blue, others are greenish, yellow, orange or pink. Crookes records that when diamonds are bombarded with cathode rays, they emit a light which may be bright-blue, pale-blue, apricot, red, orange, yellowish-green or pale-green. Such observations, even when made on many diamonds, although of considerable interest, are of little scientific value unless they can be correlated with other properties of the particular specimens observed. When placed in an X-ray beam, all the diamonds that I have observed fluoresced, if at all, with a greyish-blue colour, some more strongly than others. In most cases the luminescence ceased immediately the X-rays were cut off, but in others phosphorescence continued for several minutes and only died away gradually.

Or consider the colour of diamonds. Really clear-white diamonds are comparatively rare; most diamonds have a slight tinge of colour, and in many the colour is quite marked. But these colours are not necessarily stable; yellow diamonds are said to be comparatively difficult to change, but there are records of green stones which have become colourless, yellow or brown, when heated in an atmosphere of hydrogen; of black, brown and dark-green stones that have become violet. One colourless diamond heated in the absence of air became rose-coloured and retained this colour for several days in the dark, but the colour disappeared in sunlight, though it could be regained by reheating. On the other hand, a rose-coloured diamond became colourless when heated, but later regained its colour. Occasionally the colour is only skin-deep. Sometimes the colour changes are relatively uniform. Diamonds when strongly heated turn black, and when exposed to the α-rays of radium they turn green, but revert to their original colour on heating.

The density of diamond has been variously given as ranging from 3·01 to 3·56 gm./c.c., yet the distance apart of the carbon atoms of which the crystal is composed varies by not more than about 1 in 7,000 from one specimen to another. The true density, corresponding to the structure, is 3·515 gm./c.c. The observed variation on the light side may be due to gas or liquid inclusions, to the presence of light foreign atoms such as hydrogen or boron, or to the fact that the diamond investigated is not a single crystal. The forms of industrial diamond known as boart, carbonado or ballas tend to be light simply because they are variously arranged aggregates of very small diamond crystallites, and no aggregate of crystallites can ever occupy as little space as a single crystal of the same weight. Variations of density on the heavy side must be due to the presence of heavy impurity. F. G. Chesley (1942), using thirty-three diamonds from different localities, found by means of spectroscopic examination that aluminium, silicon, calcium and magnesium were present in all of them. He detected also the occasional presence of nine other heavy elements; but, apart from what may have been chance coincidences, he was unable to correlate his observations with the colour, habit or fluorescence of the specimens used. By the method he adopted, however, he could not have detected the presence of hydrogen, boron, nitrogen, oxygen, phosphorus, sulphur or the halogens, some of which are very probable impurities.

There are many important properties, however, which all diamonds possess in common. They are all composed mainly of carbon atoms, arranged to give cubic symmetry. The structure, determined in 1913 by W. H. and W. L. Bragg, consists of two interpenetrating face-centred cubic patterns, separated from each other by a translation of a quarter of the cube diagonal. The side of the unit cell is $3559 \cdot 65 \pm 0 \cdot 25$ X.U. (a real variation), giving a C—C separation of $1541 \cdot 37 \pm 0 \cdot 11$ X.U., or nearly 1·5445 A. It is interesting to note that each carbon atom in the structure is surrounded tetrahedrally by four others. It appears that in diamond the four valencies of carbon must be tetrahedrally directed, a beautiful confirmation of the theory of van t'Hoff, who postulated such a tetrahedral arrangement in order to explain the existence of *d*- and *l*-isomers of organic compounds containing an asymmetric carbon atom. This theory was also the foundation of Pasteur's work on the optical activity of the tartaric acids. We find that this tetrahedral arrangement of the carbon atom valencies is preserved, at least approximately, in all the aliphatic compounds, such as the sugars, paraffins and fatty acids.

One consequence of the tetrahedral arrangement of valency bonds is that diamond is not nearly so dense as it would be if the carbon atoms were close-packed. If atoms 1·54 A. in diameter were built up into a *simple* face-centred cubic pattern, the density of the resulting structure would be 7·653 gm./c.c. instead of 3·515. It is clear, therefore, that the hardness of diamond, its resistance to abrasion, which is one of its most remarkable and useful features, is not due to its compactness; for it would, in fact, be possible to pack more than twice as many atoms into the space actually occupied by the carbon atoms of diamond. It is rather due to the fact that each atom is sharing electrons with all its four neighbours in such a way as to build up a system of great engineering stability, which may be regarded either as one large molecule or as a series of interlocking long-chain molecules of immense length. Figs. 1 and 2 illustrate the types of chains that are associated with the projections along the cube axis and face diagonal respectively. Each atom is common to four chains of each type.

* Afternoon lecture at the Royal Institution delivered on March 30.

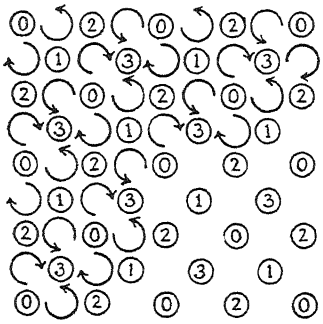


FIG. 1. INTERLOCKING SPIRALS SEEN IN PROJECTION ALONG CUBIC AXIS. 0, 1, 2, 3 ARE ON DIFFERENT LEVELS.

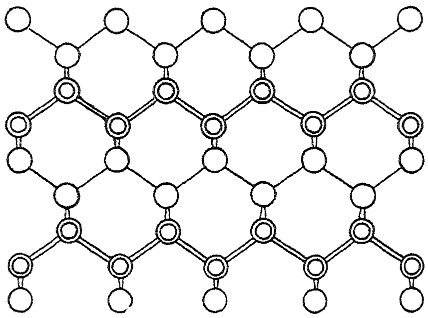


FIG. 2. INTERLOCKING ZIGZAG CHAINS (AS IN LONG-CHAIN PARAFFINS) AND CHAINS OF PUCKERED HEXAGONS (AS IN CONDENSED CYCLOHEXANE DERIVATIVES) SEEN IN PROJECTION ALONG A FACE DIAGONAL.

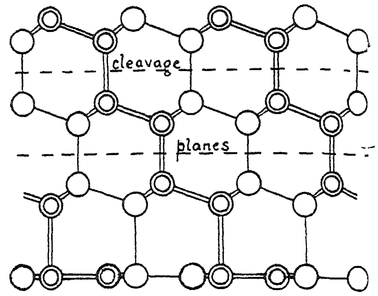


FIG 3. ARRANGEMENT OF CARBON ATOMS IN OCTAHEDRAL PLANES (111), AND FORMATION OF PSEUDO-GRAPHITIC LAYER AT SURFACE OF DIAMONDS.

○, ATOMS IN PLANE OF PROJECTION. ◎, ATOMS ABOVE AND BELOW PLANE OF PROJECTION.

We may expect that the presence of all these almost infinitely long chains will give diamond, *par excellence*, the properties that we have learned to associate with the *length* direction of long-chain molecules. It is always found, for example, that the highest refractive index γ in any organic crystal where the molecules are arranged in roughly parallel positions is associated with the longest dimension of the molecule, and that the longer the molecule, the higher the index. This property is used by crystallographers in order to help to determine the orientation of the molecules in unknown structures. We should expect, therefore, that the refractive index of diamond would be high ; it is, in fact, higher than that of any other known substance, and it is because of this quality and because of its high dispersive power that diamond, when cut as a gem, not only flashes brilliantly, but also flashes with all the colours of the rainbow.

There are not so many accurate data for the heat conductivity in various directions in single crystals, but there are enough to show that the conductivity is a maximum in the direction of the chain-length for crystals of any kind of electronic constitution, and that it is greater for perfect than for imperfect crystals. We are not surprised, therefore, to find that the thermal conductivity of diamond is high, as a simple experiment will prove ; it is higher than that of some metals and nearly 200 times that of glass. Dr. A. Müller has shown that the linear thermal expansion and compressibility of long-chain compounds are markedly less along the direction of their length than at right angles to that direction ; and we may expect, therefore, that for diamond the linear coefficient of thermal expansion will be small (it is one tenth that of glass and one twentieth that of silver), while the bulk modulus, or resistance to compression, will be large.

	Thermal conductivity	Linear coefficient of thermal expansion	Bulk modulus	Young's modulus
Diamond	0·35 at 18° C.	$0{\cdot}9 \times 10^{-6}$	$6{\cdot}0 \times 10^{12}$	$5\ 5 \times 10^{12}$ dynes/cm.²
Tungsten	0·35 ,,	4·3 ,,	3·04 ,,	3·91 ,, ,,
Steel	0·11 ,,	11·0 ,,	1·6 ,,	2·2 ,, ,,
Silver	1·00 ,,	18·8 ,	1·0 ,,	0·75 ,, ,,
Glass	0·002 ,,	9·0 ,,	0·5 ,,	0·7 ,, ,,

These properties are, of course, related to the toughness of diamond in wear, to the ability with which it will stand up to large pressures and to big and sudden changes of temperature, and therefore to its usefulness for industrial purposes. The forces of cohesion are not the same in all directions ; the very fact that diamonds usually grow as octahedra shows that, in the process of growth, atoms can be attached most easily in the direction of the cube axes and least readily along the body diagonals of the cube. Conversely, solution effects have shown very spectacularly that atoms are most easily detached along the cube directions, and in the same way diamond dies, after prolonged use, show signs of wear which is definitely a function of direction ; while it is a matter of common experience that diamonds cannot be polished along the 'grain' of their octahedral faces. The cleavage on the octahedral planes constitutes a point of weakness ; diamond dies often give way by fracture along a cleavage plane, and when diamonds 'burst' spontaneously, as they sometimes do*, it is also by octahedral rupture. Compared with that of many other crystals, however, the cleavage of diamond is difficult, because valency bonds have to be broken (Fig. 3) ; whereas in graphite, for example, the forces between successive atomic layers are so weak that slipping can easily occur. Hence the use of graphite as a lubricant. Diamonds, however, are also very slippery crystals to handle ; and it is possible that the electron orbits in the surface atoms may easily assume a pseudo-graphitic configuration, a hypothesis that would help to explain why diamonds can be electrified by rubbing.

Some properties of diamond, therefore, differ widely from one specimen to another, while other properties are shared in common by all. Let us now consider those respects in which diamonds seem to divide themselves into two types, well-defined although not altogether clear-cut. About ten years ago, Sir Robert Robertson and Drs. J. J. Fox and A. E. Martin found that whereas most diamonds showed an absorption band at 8 μ (1,288 cm.$^{-1}$), six out of three hundred specimens did not. In the ultra-violet region a similar difference existed ; the same six diamonds were transparent as far as 2250 λ, although most diamonds are opaque to radiation beyond 3000 λ. Later investigation on large numbers of diamonds from South Africa and India has shown that the 'transparent' diamonds are rare, but occasionally—such are the vagaries of the diamond—very small collections have proved to be all, or nearly all, of this rare type. Chesley found one 'transparent' diamond among those that he tested and it happened to be the purest of them all, but it would be most unwise to generalize from this one observation. The dangers of generalizing

* Two such specimens, lent by Prof. W. T. Gordon, were shown.

even from a number of observations are illustrated by the fact that Robertson and his colleagues found that most type I (opaque) diamonds were optically anisotropic, presumably owing to strain, but that the six type II (transparent) diamonds were nearly isotropic; Sir C. V. Raman, on the other hand, has found that type II diamonds sometimes show considerable restoration of light between crossed nicols, while many type I diamonds are isotropic. Most observers agree that type II diamonds tend to show a fine lamellar structure, and Prof. E. N. da C. Andrade and Dr. Martindale found that minute silver crystals would grow at random on the surface of a type I diamond, but along parallel (straight or curved) lines on a type II specimen. Scarcely sufficient crystals were examined, however, to be certain that this behaviour is characteristic.

About four years ago, Sir C. V. Raman directed attention to some anomalous spots and streaks associated with the X-ray reflexions from the octahedral planes of diamond, these being easily observable on Laue photographs taken in certain orientations. This phenomenon was investigated in great detail at the Davy Faraday Laboratory, and similar effects were found in association with other reflexions also, but no theory was found that would satisfactorily explain *all* the facts; nor is such a theory yet available. A suggestion by Sir Robert Robertson that it would be of interest to examine the Laue photographs given by both types of diamond was taken up, with most interesting results. It was found that whereas all type I diamonds gave the anomalous streaks with more or less intensity, type II diamonds showed no trace of them at all, nor of the other anomalous non-Laue effects observed in other orientations, although *all* diamonds gave extra spots due to thermal vibration of the atoms. The diamonds tested included several of those originally examined by Robertson *et al.*, as well as many others found to be either 'opaque' or 'transparent' in the ultraviolet. It was found, moreover, that type II diamonds were much better reflectors of X-rays than type I. A further difference was found in divergent-beam X-ray photographs, for type II diamonds always gave a clear, sharply contrasted pattern of absorption and reflexion lines, whereas the best type I diamonds gave a foggy picture on which few, if any, lines could be seen at all. These later observations definitely prove that type I diamonds are, generally speaking, 'perfect' in structure, but that type II diamonds are 'mosaic', that is, composed of small crystallites not quite regularly arranged. This fact, however, does not explain all the observed differences between the two types of diamond (which are tabulated below), although it does explain some of them. There is *no* difference in C—C spacing, Raman frequency, or specific heats at low temperatures.

DIFFERENCES BETWEEN TYPE I AND TYPE II DIAMONDS

Type I (relatively perfect)	Type II (mosaic)
(1) Common.	(1) Rare, in general.
(2) Infra-red: absorbs at 8 μ.	(2) Infra-red: transparent at 8 μ.
(3) Ultra-violet: absorbs beyond 3000 λ.	(3) Ultra-violet: transparent to 2250 λ.
(4) Often perfect octahedra, with perfect surface.	(4) Often lamellated.
(5) Give streaks and triangles on Laue photographs.	(5) No streaks or triangles on Laue photographs.
(6) Reflexions of moderate intensity.	(6) Reflexions very intense.
(7) Poor divergent-beam photographs.	(7) Excellent divergent-beam photographs.
(8) Slight photoconductivity.	(8) Marked photoconductivity.

A consideration of growth phenomena in crystals generally shows us that, in order to obtain 'perfect' crystals, slow and uniform variation of conditions is necessary; slow, regular evaporation or fall of temperature, for example. 'Mosaic' crystals are formed when growth is more rapid or irregular. Although the problem as to how diamonds were formed in Nature is still unsolved, it seems fairly certain that their growth was slow. Diamonds are mined from pipes of igneous origin, where they are found in the 'blue ground', kimberlite; but they almost certainly did not originate there. They are also found in alluvial deposits in river beds, and they have been thrown down from the skies in meteorites. Some of the earth-formed diamonds are not only huge (the Cullinan, which weighed nearly 1 lb. 6 oz., was obviously only part of a still larger diamond) but also practically perfect crystals, from which many superb gems can be cut. Scientific workers are not usually interested in crown jewels or even tiaras, but they would like to be able to make diamonds under controlled conditions. Rubies, sapphires, chrysoberyls, spinels and other gem materials can be made in the laboratory; why not diamond? The main answer is, of course, that in spite of its hardness and inactivity, diamond is not the most stable form of crystalline carbon, at least under ordinary temperatures and pressures. A great many attempts were made in the nineteenth century to find conditions under which carbon could be made to crystallize as diamond rather than as the more stable form, graphite. Moisson's well-known attempts to crystallize pure carbon from solution in iron or silver were believed by many, including Sir William Crookes, to have been successful, but none of his specimens remain. Sir Charles Parsons tried to melt carbon by the imposition of enormous instantaneous pressure and temperature, and also by means of hydraulic pressure and electrical heating; he tried to repeat and improve not only Moisson's method, but also the methods of all previous workers who had claimed any measure of success; and he tried other new methods; but towards the end of his life he and his assistant, Mr. Duncan, became convinced that neither they nor anyone else had ever succeeded in making diamond in the laboratory.

Meanwhile there were, in the possession of the Mineral Department of the British Museum, twelve minute crystals on a glass slide, labelled as being diamond, artificially prepared and presented by J. B. Hannay in 1880. These were presumably the remains of those tested and pronounced to be genuine diamond by Prof. Story-Maskelyne, the keeper of minerals at that time. Hannay's method was to take a mixture of 'paraffin spirit', bone oil and solid lithium, place it in a wrought iron tube which was then closed by welding, heat the tube in a reverberatory furnace for fourteen hours at a dull red heat and then, if it had not exploded, allow it to cool slowly. It was usually found that the iron had become porous on heating and had not held the pressure; but in three experiments out of eighty, the pressure *was* held in some way, for on opening the tube there was a rush of gas given off. A hard smooth mass which was found adhering to the inside of the upper end of the tube was crushed and some hard transparent crystals were found, some of which were tested by Hannay and some of which were sent to the British Museum for Prof. Story-Maskelyne to test. The report of Hannay's success was greeted by the scientific world of his day first with acclama-

tion, then with incredulity and finally with suspicion. It was thought that a practical joke may have been played upon him by an assistant, but according to Sir James French, who as a boy knew Hannay and who remembers the circumstances of the experiment, Hannay was well aware of this possibility and guarded against it. Hannay repeated the experiments a year later, using various tube linings; and he claimed success in four out of thirty-four experiments at this later stage. Other scientific workers accepted the experiment as genuine but believed that the crystals obtained were a carbon-rich form of carborundum, which is not unlike diamond in structure, appearance and properties. So late as 1902 Hannay indignantly refuted this suggestion, which had been made in the "Encyclopædia Britannica" of that date. An X-ray investigation of the twelve crystals preserved at the British Museum has proved definitely that eleven of them are diamonds; many of them show striations similar to those found on type II diamonds, and a special investigation of one specimen has proved that it is, in fact, a type II diamond. In spite of its minute size (less than 0·05 mgm. or 0·00025 carat) it is an excellent reflector, but it shows no signs of the type I streaks or triangles, although it shows the 'thermal spot' common to all diamonds. Although type II diamonds are comparatively rare in Nature, it is this mosaic type that one would expect to be formed under the relatively hurried conditions of a laboratory experiment. We can prove that the crystals are diamonds, but we cannot prove that Hannay made them. All things being considered, however, it seems only right to assume that he did; the matter was discussed at length in the correspondence columns of NATURE in 1943.

In some ways the problem of diamond is like a crossword puzzle. We have clues, but in some cases we do not know the solution; in other cases there seem to be more than one possible solution. But as Sir William Bragg said many years ago: "There is no cross-word puzzle that can compare in interest with the practical working out of a problem in Physics or Chemistry. You may say that to work at an amusing thing is not a very noble task. I can only answer that it makes a very happy life and I think that, if we can increase the number of human beings who find happiness in their work, we shall have gone some way towards creating a better state of things."

CHUNGKING INDUSTRIAL AND MINING EXHIBITION

By DR. JOSEPH NEEDHAM, F.R.S.
British Scientific Mission in China

DURING March an important Exhibition of Technology organized by the National Resources Commission (part of the Chinese Government's Ministry of Economic Affairs) was held in Chungking. This exhibition, which has attracted daily many thousands of visitors, deserves a world attention wider than the interest of the inhabitants of the Chinese capital, since it signalizes in a striking way the determination of China to embark upon large-scale industrialization, by which alone the standard of life of the masses in China can be permanently raised.

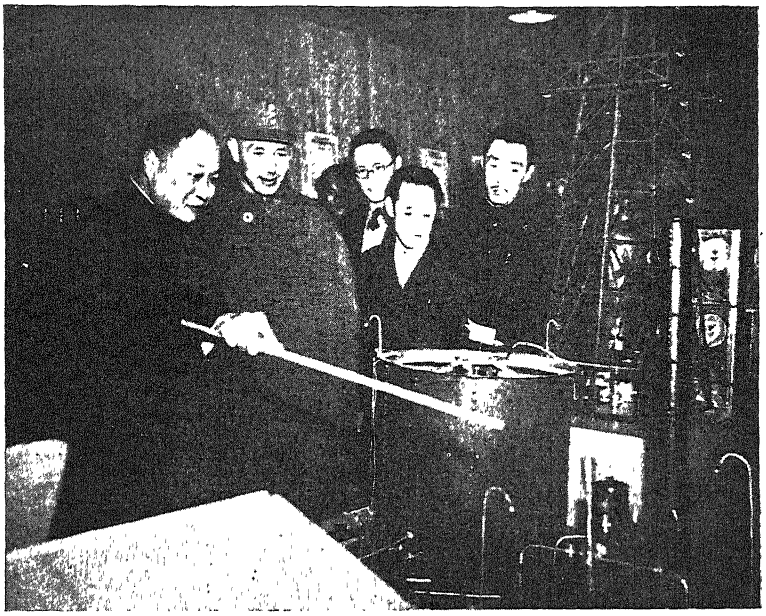
The exhibition occupied large and spacious hall, specially constructed for the occasion entirely of bamboo poles and matting, and set up on the campus of the Chiuching Middle School in pleasant surroundings. Facing the visitor in the imposing entrance-hall were the devices (acting as badges stimulating *esprit de corps*, as well as trade-marks) of the 105 mines and industrial plants operated by the National Resources Commission in Free China, that is, in the south-east, south-west and north-west parts of the country. The Commission employs some 170,000 workers, part of whom are skilled, and 12,000 staff, of whom some 42 per cent are trained engineers, chemists, etc., and 23 per cent in the administrative division. The walls of the entrance-hall were covered with maps and charts, and below were displayed a remarkable collection of mineral geological specimens, arranged with the aid of the Chinese Geological Survey. Here it may be observed that China produces 70 per cent of the world's antimony. Here one could handle a specimen of the ponderous tungsten ore, wolframite, of which China is the leading world producer. In the centre of the hall was an exhibit which should have been very educational for the Chinese public—a display of all the old provincial weights and measures side by side with the standard measures of weight and capacity. The importance of standardization was also shown by a medley of pieces of electric equipment, none of which will fit each other, presumably the result of pre-war purchases from Western countries, and showing the necessity of one standardized industry for all China. An idea of what standardization means was also given by a well-arranged exhibit of gun parts supplied by the arsenals of the Chinese Ordnance Administration.

Mining and Metallurgy

Proceeding along his fixed path, the visitor came next to the section on coal and oil. Here there were excellent stratigraphic mine models, pictures of types of transport, and a historical series showing the evolution of the miner's lamp in China from the Roman-style oil wick to the modern battery light. In the oilfield section, there was a magnificent model of the Kansu field in its desert mountains, and a number of working models not only of drilling derricks (about 6 ft. high) but also of the refinery. There were also actual specimens of the drilling bits and jigs, and a display of the various refinery products.

After this, the visitor reached the iron and steel section. There was a short historical exhibit going back to ancient Egyptian iron technology, and ending with modern metallographic pictures. The model blast furnaces were particularly fine, standing about 10 ft. from the ground and complete in every detail. One in particular was of interest as the original was largely built out of steel plate salvaged from river-steamers destroyed by bombing.

The metallurgical department continued into the non-ferrous metals section, which was particularly good. The display of specimens of economic minerals in the entrance hall, to which reference has already been made, was repeated on a smaller scale in each of the non-ferrous and mining halls; a very fine educational idea, since anyone who failed to take in the full import of the various minerals when he first saw them, could turn aside from the metallurgical models and familiarize himself with the ores on which the industries are based. Interesting copper-aluminium alloys with properties similar to nichrome steel were shown by the Electrochemical and Metallurgical



GENERALISSIMO CHIANG KAI-SHEK INSPECTING THE OIL-FIELD EXHIBIT. LEFT TO RIGHT: DR. SUN YU-CHI, GENERAL MANAGER OF THE KANSU PETROLEUM ADMINISTRATION; GENERALISSIMO CHIANG KAI-SHEK; DR. CHIEN CHANG-CHAO, VICE-CHAIRMAN OF THE NATIONAL RESOURCES COMMISSION; DR. WONG WEN-HAO, MINISTER OF ECONOMIC AFFAIRS AND CHAIRMAN OF THE NATIONAL RESOURCES COMMISSION.

Works at Sanchi under the direction of Dr. Yeh Chu-Pei (Yap Chu-Phay). This same works recovers zinc and copper from the bronze coins of former dynasties, of which a large stock has been collected, as well as smelting the native ores. It also produces copper of ordnance standard by electrolytic purification, of which an excellent working model was shown. Bauxite has now been discovered in Yunnan and Kweichow provinces, and an ingot of aluminium bears the triumphant inscription "The first Al sample industrially produced in China, at 4.30 p.m. on Dec. 11th, 1943". The sump mining of cassiterite tin ore was illustrated by an excellent timber model showing the washing troughs, and there was a working model of a tin smelting and purification plant. In the washing of wolframite ancient traditional wooden implements are used, also shown in model form. Particularly interesting is the technology of mercury. There were beautiful specimens of cinnabar, that precious substance of the early Chinese alchemists, and a series of models illustrated the different types of traditional smelting furnaces used in the different provinces. Finally, the antimony industry showed antimony ingots and models of paint-production plants.

Leaving the metallurgical section, one entered that of the refractories, where a large variety of heat-resistant bricks and acid-resistant stoneware was shown. There was a good display of China-made Seger cones.

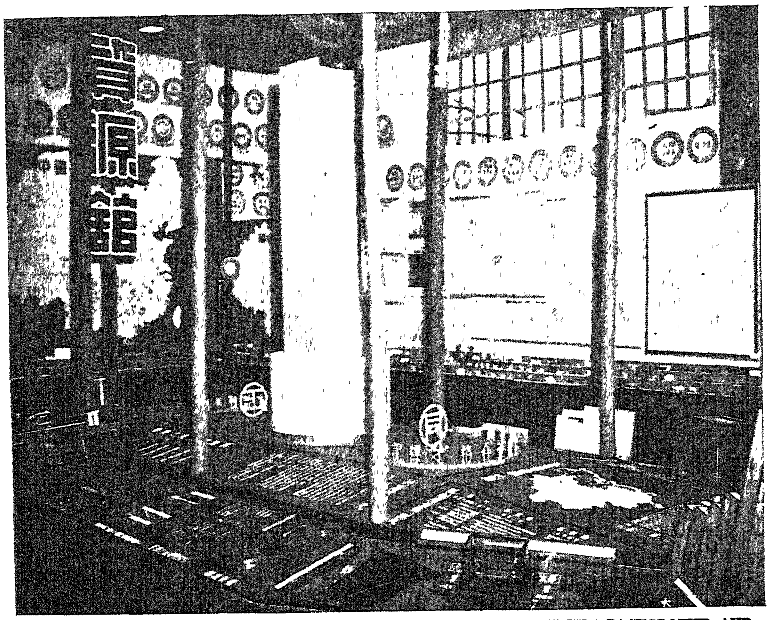
Chemical Industry

Next came the chemical industry. The production of power alcohol, so wisely encouraged as a contribution to blockaded China's supply of transportation fuel, was represented by a fine series of models, notably that from Dr. Chang Chi-Hsi's plant, and good exhibits, both on the chemical and the mycological sides. The production of petrol by cracking vegetable oils, the other main contribution to the fuel supply, was illustrated by a working model of a pipe-still, cracking chamber, and fractionating column, made entirely of glass, from the Tungli works (Dr. Hsu Ming-Tsai and Dr. Sun Tsun-Chueh). On an adjacent stand, surrounding a young tung oil tree, were shown all the products which may be (and, in most cases, are being) made from the oil, such as candles, margarine, vanishing cream, paint, varnishes, printing inks, solvents, lubricating oils, plastics, kerosene, petrol, Diesel oil, tar, and even oil-resistant synthetic rubber (through ethylene to thiokol). When tung oil petrol is no longer needed after the War, it should still be possible to base a great industry on the tung oil plantations.

Engineering

The electrical industry exhibits were arranged around a circular domed hall, indirectly lit, and with grass and herbs strewn on the ground. Music for the whole exhibition was provided by Chinese-made radio gramophones in the radio section. Among the great variety of apparatus shown in the hall one noticed aviation ground-station equipment transmitters of 20–100 m. frequency range (input 2 kW.: output ½ kW.); short-wave broadcasting transmitters for interprovincial communications (input 4 kW.: output 1 kW.); scrambler sets; radio beacon transmitters; military walkie-talkie sets with bamboo aerials; hand and 1-h.p. motor generators; 5-tube superhet receivers; 8- and 10-tube communications receivers (pronounced by an expert to be as good as any in the world); universal meters for currents and resistances; 50-watt public address system amplifiers; a very large assortment of radio valves; telephone exchanges with the receivers of lacquered wood owing to the plastics shortage; motors and switchgear; and intercommunication telephones. On an average, 88·3 per cent of the component parts of all this apparatus was made entirely in China; only in the case of some valves and meters are the Chinese still dependent on imports from abroad. They hope to raise the figure to 97 per cent this year. Besides all this apparatus, there was a wealth of wire and cables of all sizes, electric bulbs, dry cells and batteries, telegraph insulators and high-tension devices, silk- and rubber-covered flex, large accumulators made of wood and covered on the inside with an acid-resistant tung oil paint. One very educative exhibit was an illuminated circuit-diagram of a radio set actually working, and another was a flowsheet with all the component parts and their method of manufacture inserted. The biggest piece of Chinese-made apparatus in this section was a 1,200 kVA. step-up transformer for use in a phosphorus factory. Very good porcelain lamp sockets and switches of simple design replace plastic ones.

No less impressive than the preceding sections was that devoted to hydraulic power. The existing and planned power grids were shown on very clear maps, and there were a number of beautiful topographic running-water models which strikingly explain how various natural features in river flow can be made



ENTRANCE HALL, WITH GEOLOGICAL MAPS AND COLLECTIONS IN THE BACKGROUND AND THE STANDARDIZATION EXHIBIT IN THE FOREGROUND.

use of. Thus the Changshou plant has no dam, but a mill-race channel some 2 km. long, partly roofed as protection against land-slides, and leading to a penstock of 43 ft. fall. At Wanhsien, on the other hand, there is a low dam on top of a natural rock waterfall, and a rock-cut tunnel giving a fall of 45 ft. and an output of 300 kW. At Shanyuting the mill-race channel is carried over a side-stream by a viaduct before it reaches the penstocks, and gives rise to 1,500 kW. At Taohuachi the tunnel cuts across the short side of an isosceles triangle made by the river, short-circuiting several natural falls, and achieving a penstock fall of 270 ft. giving 900 kW. Some idea of the planned capacity of these west China networks may be gained from the following figures :

East Szechuan	647,000 kW.
West Szechuan	700,000
Kweiyang (Kweichow) ..	90,000
Kunming (Yunnan)	50,000
Djenbei	175,000
Hsiangchung	370,000
Ohsi	320,000
Hsibei (Kansu)	40,000

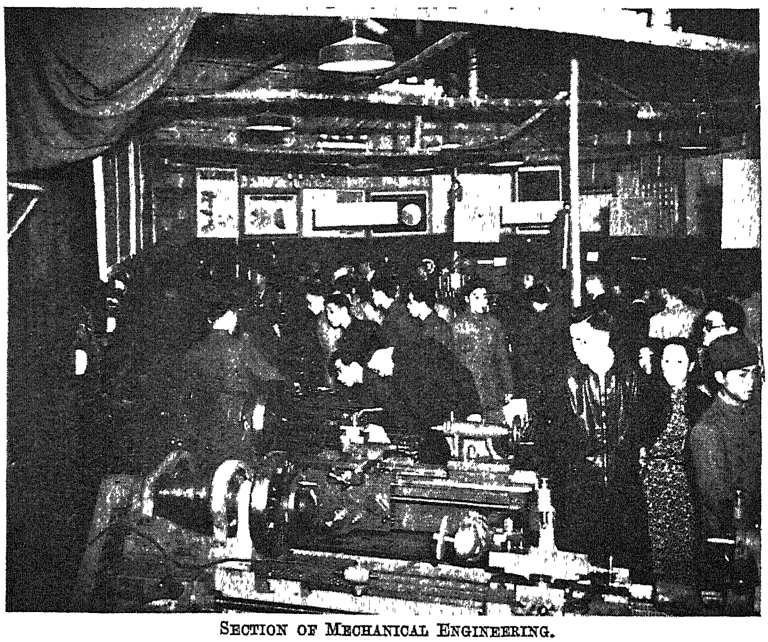
Not without interest, too, were the models of the high-tension line methods employed, the pylons being constructed mainly of wood.

The last section was that of mechanical engineering, showing the products of the different machine works. One saw first three models of power plants manufactured in China recently, namely, one 2,000 kW. boiler plant and two 150 h.p. water turbine and generator sets. On the other side were exhibited an actual six-cylinder stationary Diesel engine and generator set of 300 h.p. and one 10 h.p. gas engine set. Next in line came the various types of industrial machinery and motor-vehicle parts and also a set of village cotton-spinning machinery. The farthest corner contained the exhibit of precision tools and machine tools. The former included many items in common use such as lathe and drill chucks, gear cutters and hobs, micrometers and surface plates, while the latter included bench motor drills, drill presses, lathes, shapers and milling machines. Many of the items exhibited in this section were produced by China's biggest machine works, that at Kunming, directed by Dr. Wang Shou-Chin.

Throughout the exhibition the visitor noticed from time to time interesting photographs showing the welfare for the personnel (hospitals, schools, pithead baths, and the like) undertaken by the various plants. In this respect, the National Resources Commission stands as a striking example to private firms in Chinese mining and industry, where the workers' conditions are sometimes still in a distinctly backward state. Those who, like the present writer, have had the privilege of visiting many of the plants under the National Resources Commission, know that these pictures are no mere propaganda, but do actually represent the facts.

The Future

A Western man of science came away from the Exhibition with two main impressions. In the first place, from what has been said above, it is clear that under the vigorous direction of Dr. Wong Wên-Hao, Minister of Economic Affairs and chairman of the National Resources Commission, and Dr. Chien Chang-Chao, vice-chairman of the Commission, the Chinese people have now the embryo (and by no means at a very early stage) of a Science Museum on



SECTION OF MECHANICAL ENGINEERING.

the lines of South Kensington. It would be a disaster if all these models and collections, now so carefully assembled, were to be dispersed or lost, and all those interested in science and technology in other lands will agree with me in hoping that some arrangements will be made for preserving the present exhibition as a germ of a Chinese National Museum of Science and Technology. I am informed, indeed, that it is likely that some such arrangements, in conjunction with the Ministry of Education, will be made.

The second, and more far-reaching, point is, of course, that the Exhibition demonstrates, once and for all, that given the tools of the trade, Chinese technologists, engineers and scientific men are the equal of any in the world. To me, not unfamiliar with them beforehand, this came as no surprise, but it is a point which ought to be brought home to all those in Western countries who are concerned with post-war trade relations with China. Any idea that the Chinese are personally unfitted for technology and industry is a complete illusion. Any idea that they do not wish to industrialize their great country and will for ever be content to accept the industrial products of other countries is also a fatal mistake. They deserve, and should receive, every help in their industrialization. It was interesting to hear the comment of a Western diplomat who had spent many years in Japan, that in spite of the much-vaunted industrialization of that country, he had never seen there so well-arranged a technological exhibition.

At the present time, Chinese science and technology are encountering formidable obstacles. There is the state of blockade, which prevents the importation of essential apparatus if of any considerable weight; and there are the difficulties of transportation within the country, which lead to serious bottlenecks in raw material supplies; but worst of all is the financial situation, which renders all book-keeping so difficult and impedes all attempts, not only to attain all-out production, but even to reach the capacity production of the plants which have been set up with so much pain, trouble and technical skill. It seems that some urgent economic assistance is needed in this direction. Officials of the National Resources Commission say modestly that their efforts have been directed mainly to training cadres of technical men, a policy which will naturally bear fruit after the War rather than now. Nevertheless, her allies ought to find some way of aiding China to attain an all-out industrial production such as they themselves are able to carry on in the war against the Axis.

But in general, the point to be emphasized is that the Exhibition was a triumphant vindication of the technical excellence and competence of Chinese scientific and industrial workers. As such the world should take note of it. Not that the Chinese are late-comers to the world of industry. Their ancestors were using ploughs of iron when ours were using wooden ones, they printed long before Guthenberg, knew of gunpowder long before Schwarz, and made porcelain long before Pallissy. But until modern, theoretical science was born, all such achievements remained purely empirical; and modern industrialization is not, and could never have been, based on purely empirical knowledge. The Chinese, therefore, have to master applied science as a whole, just as Westerners have done. The recent Exhibition showed that they are, what John of Monte Corvino called them four hundred years ago, "di nostra qualitá".

J. B. VAN HELMONT (1579-1644)

By Dr. W. PAGEL

JEAN BAPTISTE VAN HELMONT, the great Flemish natural philosopher, died three hundred years ago, at the age of sixty-five, bringing to a close a life embittered by religious persecution, but rich in inward contentment derived from sincere piety and a magnificent record of discoveries and ingenious conceptions in science and medicine. He devised one of the early thermometers. He proposed a reform of time measurement by the use of the pendulum and devoted much work to the investigation of its laws. He endeavoured to express vital phenomena in chemical terms and thereby became one of the founders of biochemistry. He demonstrated that acid is associated with digestion in the stomach and alkali in the duodenum. He was one of the initiators of modern pathology, which he sought to base on a study of the external agents in relation to local changes in the organs in disease. This led him to a refutation of the "Folly of Catarrh"—the title he gave to one of his treatises—for it was then believed that many diseases were due to a flow of mucus from the brain straight through the base of the skull to all parts of the body, notably to the lungs and joints, causing consumption, rheumatism, pneumonia, gout. He even made practical contributions to clinical medicine, for he examined the specific gravity of urine and demonstrated the presence of carbon dioxide and ferrous oxide in the waters of Spa by means of evaporation.

In connexion with the discovery of 'acid fermentation' in the stomach, it is worth while recalling the theories of Paracelsus (1493–1541), which admittedly stimulated Van Helmont's work. Paracelsus recognized different digestive properties in the various digestive organs, such as mouth and stomach ("Opus Paramirum", III), and described the powerful support of gastric digestion by intake of acid, notably those found in spas[1], but did not regard acid as a normal secretion of the stomach, except in the case of the ostrich, which is thus able to digest metals. The 'fermenting' action of acid, for example, in food, had already been mentioned by Galen[2], but up to Van Helmont's time and for a long time after, 'heat' and 'trituration' were believed to be the actual forces of digestion in the stomach.

Critical evidence has been given[3] of Van Helmont's achievements in chemistry, of the quantitative character of his work, of his extensive use of the balance. These gave him insight into the indestructibility of matter. Thus he showed, for example, that metals are recoverable without loss of weight after solution in acid. He realized, moreover, that when one metal precipitates another from a solution of a salt there is no transmutation. He also made a clear distinction between copper and iron vitriols[4].

Van Helmont studied volatile bodies with particular care. The achievement by which he is specially remembered is the separation from air and water vapour of a "New Entity" which he called "Gas". This "new entity" involved a change in the general concepts of biology, of medicine and indeed of cosmology and philosophy[5]. Such implications emerge with any attempt to restore the original setting in which the discovery was presented.

'Gas' appears first of all to be something 'specific' to the object in which it was contained. It is thus in contrast to volatile bodies such as air and water vapour, of which all objects in Nature may partake[6]. Van Helmont sees gas as the vector of a specificity

which he believed he demonstrated in every being. Moreover, it is by virtue of its specific "gas" that an object is alive. "Life" in this sense means what later Glisson, carrying Van Helmont's conception a step further, called the "Energetic Nature of Substance". This was the point of view of Leibniz's monadology. Van Helmont, Glisson and Leibniz believed in 'forces' intrinsic *in* matter and its finest particles, but not acting *on* it. Thus the unsatisfactory dualism of 'soul' and 'body' was replaced by the idea of specifically different 'biological units' with spiritual and corporeal aspects. This was a kind of 'pluralism' which foreshadows certain modern biological concepts.

Each of these thinkers based his theories on certain scientific experiences of the day. Leibniz had in mind the innumerable organized units which the microscope had revealed in drops of water. Glisson had experience of tissue fibres and visualized intrinsic 'perception and appetite' in their fine anatomical organization, their irritability and formation of sphincters. It is no accident that it was he who discovered the rhythmic entry of bile into the duodenum and the sphincter at the orifice of the common bile duct. Van Helmont regarded the qualitatively different volatile products which he studied as the essence of various objects in Nature from which they were obtained. 'Gas' represented 'disposed' or 'organised matter' in the widest sense. Hence 'gas' as a chemical entity cannot be separated in his writings from its philosophical connotation. This is the stumbling block in his writings for most modern scientific readers. The inseparability of scientific result and philosophical implication applies to his achievements in physiology, pathology and his biological concept of time[7].

Such philosophical implications cannot be ignored in the works of seventeenth century scientific workers. Science was not yet an organized body of specialized subjects associated with the activities of full-time research workers and lecturers engaged in specially directed studies. Its status was, therefore, quite different from that which it came to assume in the following centuries. Nature as a whole, *Philosophia Naturalis* rather than a number of scientific subjects, presented itself to the scientific worker. His activities were bound to cover a much wider field and to be mingled with philosophical elements. It could not be taken for granted that the results of any particular worker were purely scientific or scientific at all, since there was no separation of philosophy and science, of belief and knowledge; though such a separation is the elementary premise of the scientific worker of the nineteenth and twentieth century. In discussing a writer of the time of Van Helmont, it is impossible to avoid discussing the original—philosophical—meaning of concepts which have now become exclusively scientific. "L'Historien des Sciences doit se faire le Contemporain des Savants dont il parle[8]." The case of Van Helmont is no isolated example of this claim.

[1] "Acetosum Esurinum." De morb. tartar., cap. 16.
[2] "De simpl. medicam temp", I, 39; ed. Kuehn. **11**, 453.
[3] Partington, J. R., "Jean Baptista Van Helmont", *Annals of Science*, **1**, 359 (1936).
[4] Partington, *loc. cit.*, p. 368.
[5] Pagel, W., "The Religious and Philosophical Aspects of Van Helmont's Science and Medicine", *Supp. Bull. Hist. Med.*, No. 2 (Baltimore, 1944).
[6] Partington, *loc. cit.*, p. 373, lists fifteen kinds of gas described by Van Helmont and rightly emphasizes the qualitative differences which Van Helmont ascribed to them.
[8] Pagel, W., "Van Helmont De Tempore and the History of the Biological Concept of Time". *Isis*, **33**, 621 (1942).
[7] Metzger, H., "L'Historien des Sciences doit-il se faire le contemporain des savants dont il parle ?" *Archeion*, **15**, 34 (1933).

OBITUARIES

Mr. Frederick Chapman

THE sudden death of Frederick Chapman, a prominent authority on the Foraminifera and a distinguished Australian palæontologist, at his home at Kew, Victoria, on December 10, 1943, within a few weeks of his eightieth birthday, severs almost the last link in the chain of workers who for nearly a century have kept Britain in the forefront of the study of the Foraminifera.

Chapman was born at Camden Town, London, his father being Robert Chapman, who was assistant to Michael Faraday and John Tyndall. At an early age, through the influence of his brother Robert, he became interested in entomology and botany, but his appointment at the age of eighteen as laboratory assistant to Prof. J. W. Judd at the Royal College of Science led to his taking up geology as his life's work. He remained at the Royal College of Science until 1902, when, on the recommendation of Judd, he was appointed palæontologist to the National Museum, Melbourne. He occupied this position until 1927, when he was engaged by the Commonwealth Government as first Commonwealth palæontologist. He retired from his official duties in 1935, but continued to engage in scientific work until his death. From 1920 until 1932 he was part-time lecturer in palæontology at the University of Melbourne. He also occupied a number of honorary positions and served as a member of the International Commission on Zoological Nomenclature for more than twenty years.

Throughout his life, Chapman possessed good health and abundant energy as well as an absorbing interest in his work, and his scientific output was exceptionally large, comprising more than five hundred books and papers. While he had a special interest in the Foraminifera, on which he covered a wider field than any other writer on the group, his publications deal with geology, palæontology and zoology. Of these may be mentioned his papers, "The Foraminifera of the Gault of Folkestone", "New or Little Known Fossils in the National Museum", his reports on the Foraminifera and Ostracoda of the Shackleton and Mawson Expeditions to the Antarctic, and his books, "The Foraminifera", "Australasian Fossils", and "Open Air Studies in Australia". It has been said that in his work in Australia he attempted too much; but, as Prof. J. W. Gregory remarked when Chapman was awarded the Lyell Medal of the Geological Society of London in 1930, "A man single-handed, in charge of a great palæontological collection, cannot however specialize. He has to do what comes to him and not what he would choose. Mr. Chapman loyally and valiantly dealt with an unusually wide range of fossils . . ." Chapman's last work was a paper dealing with the conclusion of the investigation, begun by him nearly fifty years before, of the cores from the borings put down at Funafuti by the Royal Society of London to test the correctness of Charles Darwin's theory of the formation of coral reefs. This is still unpublished.

Chapman's great services to science were recognized by his election as an associate of the Linnean Society of London (1896), the honorary fellowship of the Royal Microscopical Society (1929), the award of the Lyell Fund (1899) and the Lyell Medal (1930) of the Geological Society of London, and other distinctions conferred on him in Australia, New Zealand and the United States. One of the finest tributes to his work

in Australia was paid by the late Prof. T. W. Edgeworth David, who said: "No one in Australia since the time of Robert Etheridge, Jnr., has more enriched our knowledge of the past forms of life in Australia than has this worker, whose ability is matched to a marvellous industry".

Chapman was personally a charming companion and loyal friend. He was ever willing to give those who sought his aid the benefit of his wide knowledge and great experience. Blessed with an even temperament, he had an old-world courtesy which never deserted him. His wide circle of correspondents throughout the world particularly will regret his passing. W. J. PARR.

Mr. Arthur Earland supplements this account as follows:

Of recent years, much of Chapman's work on the Foraminifera was done in collaboration with Mr. W. J. Parr, including "A Classification of the Foraminifera", published in 1936, which is probably the best and most natural of the many efforts to deal with this difficult subject. They were also jointly responsible for the long-delayed report on the Foraminifera of the Australasian Antarctic (Mawson) Expedition of 1911–14, published in 1937.

Mr. C. B. Rickett

C. B. RICKETT, who died on April 8 at the age of ninety-two, was the last of a triumvirate of British ornithologists who did so much for the study of Chinese ornithology at the end of the nineteenth and beginning of tho twentieth centuries.

Charles Boughey Rickett was born in Hong Kong on December 10, 1851, and was the son of John Rickett, who was in the service of the East India Company. At an early age he joined the Hong Kong and Shanghai Banking Corporation, and after serving in branches in India, Japan and Java, was appointed agent at Penang in 1885, and five years later was transferred to Foochow. He had been collecting birds while in the Straits, but he did not take this up seriously until he arrived at Foochow. J. D. La Touche had already written about the birds of that area, but Rickett, after four years work, was able to add much additional information.

The two ornithologists became great friends and wrote more than one joint paper. Through La Touche, Rickett came to know F. W. Styan, who was engaged in the tea trade and an authority on the birds found in the Yangtse Valley. The three carried out a joint trip to the hills north of Foochow which resulted in several interesting discoveries; later they combined to send Chinese collectors to less accessible parts of China—with valuable results.

Rickett was a good field observer, and his papers contained many interesting notes. His collections, amounting to some four thousand skins and a thousand eggs, and a considerable number of mammals, were presented to the British Museum. After his retirement he lived in England and finally settled in Reading. He was a very regular attendant at the monthly meetings of the British Ornithologists' Club up to his eightieth year, and was one of the best known and popular members. N. B. KINNEAR.

WE regret to announce the following deaths:

Prof. Wilhelm von Mollendorf, professor of anatomy and director of the Anatomical Institute at the University of Zurich, aged fifty-seven.

Dr. Daniel M. Molloy, field director in Central America for the International Health Division of the Rockefeller Foundation, on January 29, aged sixty-one.

Mr. J. R. Norman, deputy keeper in the Department of Zoology, British Museum (Natural History), an authority on fishes, on May 26, aged forty-five.

Prof. S. Oberndorfer, director of the Institute of General and Experimental Pathology and of the Cancer Institute of Istamboul University, on March 1.

Prof. Wolfgang Ostwald, professor of colloid chemistry in the University of Leipzig, aged sixty.

Sir Herbert Thompson, Bart., the well-known Coptic scholar, on May 26, aged eighty-four.

NEWS and VIEWS

Association of Teachers in Technical Institutions

SOME problems likely to face the technical colleges as a result of the application of the 1944 Education Bill formed the main theme of Mr. H. Wragg's presidential address to the Association of Teachers in Technical Institutions at the thirty-fifth annual conference. After indicating the needs of democracy for a knowledgeable and discerning electorate and ability "to create and develop ideas which will ameliorate the life of the community", Mr. Wragg surveyed the deficiencies of past educational legislation in so far as it touched the technical field, and welcomed the recognition given to the present junior technical schools by their being placed on the same footing as the grammar and modern schools. He directed attention to the problems involved in providing more school buildings and additional teachers to meet the expanding situation. The erection of new buildings takes considerable time but "time and cost of manufacture and erection are greatly reduced when many things of the same pattern are required". Mr. Wragg felt that teachers of building would find in this problem great scope for their energies. Already new junior technical schools of building have been opened. As to teachers, the vast number required (estimated at 50,000–100,000) "can only be secured if the profession is attractive to new entrants"; and revised salary scales are now under discussion (see also p. 663 of this issue). The need for close co-operation of technical colleges in compulsory part-time education from fifteen to eighteen was indicated, and the hope expressed that part-time day release would extend (voluntarily) until the age of twenty-one. Opportunities should be seized for expanding full-time courses for suitable students. The new Bill gives unsurpassed opportunities for local education authorities to erect "an all-embracing educational structure on the firm broad basis of primary and secondary education for all", with towers corresponding respectively to the universities and the technical, commercial and art colleges.

The Nutrition Society

THE science of nutrition expanded so much of recent years that it was no longer adequately covered by existing societies. In July 1941, therefore, a proposal to form a nutrition society was put forward, under the auspices of the heads of various well-known institutes engaged in research on nutrition in Britain, which would follow on the lines of the Physiological and Biochemical Societies, although there was no question of publishing a journal at that time. At the first meeting in the same month, it was felt that the main object of the new Society should be to form a common meeting place for workers in the various fields of nutrition, namely, physiological, biochemical, agricultural, medical, sociological, economic and public health, and that it would be useful during the War to have a separate Scottish Group. The Society had not long been founded when it became apparent that the value of its proceedings would be enhanced by their reaching an audience wider than that which actually participated in its meetings. The Royal College of Physicians, impressed with the advantage which the medical profession might reap from gaining immediate access to the records of the meetings of the Society, made an offer which enabled the financial and other difficulties standing in the way of publication during war-time to be overcome. Accounts of the first meeting and of English and Scottish Group meetings up to May 30, 1942, are now published (*Proc. Nutrition Soc.*, 1, Nos. 1 and 2, 1–112; 1944) and include "Evaluation of Nutritional States; Food Production, Distribution and Supplies in Relation to Human Needs", and "Problems of Collective Feeding in War Time". The second double number will contain reports of meetings on dehydration, food supplies, trace elements and diet in pregnancy and lactation.

British Medicine and the Göttingen Medical School

IN a recent paper (*Bull. Hist. Med.*, 14, 449; 1943) Prof. Max Neuburger remarks that during the eighteenth century inadequate facilities for teaching and research prevented most of the medical schools in Germany from furthering either medical training or scientific research. On the other hand, the medical school at Vienna and the Medical Faculty at Göttingen were remarkable exceptions, and owed their celebrity to two famous pupils of Boerhaave, namely, Gerhard van Swieten at Vienna and Albrecht v. Haller at Göttingen. George II, who founded the University of Göttingen in 1734, invited Haller to fill the vacant chair of medicine, which included anatomy, surgery and botany. Haller had previously spent some time in London, where he made the acquaintance of several English physicians and surgeons such as Sir Hans Sloane, John Pringle and William Cheselden, and frequently quoted British writers, notably Stephen Hales, John Mayow and Thomas Willis, in his own works. During the seventeen years when he resided at Göttingen, he exercised a great influence on the University, being responsible for the erection of an anatomical theatre, a botanical garden and a lying-in institution. He also founded a scientific society of which he was the first and permanent president, and a scientific journal to which he made more than a thousand contributions. Between 1739 and 1744 he completed the six-volume edition of Boerhaave's "Institutiones", for which he was elected a foreign member of the Royal Society. He was also author of numerous other works on anatomy, physiology, medicine, surgery and botany. In 1739 he was appointed physician in ordinary to George II, who conferred a knighthood upon him and made him one of his consultant physicians. Owing to reasons of health, he left Göttingen for Berne in 1753. Many of Haller's successors at Göttingen, as Prof. Neuburger points out, had studied in London. Among them may be mentioned Roederer, Sömmering, Thomas Young and Blumenbach.

Quekett Microscopical Club

FOR some eighty years, the Quekett Microscopical Club has taken a leading part in the development of microscopy, and many leading research workers have been included on its membership roll and have recorded the results of their work in its journal. Thanks to the courtesy of the Royal Society, the Club, which at present has a membership of nearly three hundred and fifty, is now meeting at Burlington House, Piccadilly, where the Club's library and slide cabinet are again available, after having been removed to safety in the country during the last four years. Meetings are held as originally, on the second and fourth Tuesday in each month, the earlier being an ordinary (lecture) meeting, whereas the latter is devoted to the exhibition of specimens, apparatus and general discussion. On Saturday afternoons, collecting excursions are conducted and visits to places of interest to microscopists are arranged. The affairs of the Club are managed by two secretaries: Mr. E. P. Herlihy, 76 Brook Green, London, W.6, dealing with business matters, and Dr. James Davidson, 41 Brampton Grove, London, N.W.4, with scientific matters and papers.

Chagas's Disease in Brazil

IN a recent paper (*Bol. Of. San. Panamericana*, 22, 773; 1943), C. Chagas, jun., states that during the thirty-three years since Chagas's disease was discovered in a small area in the State of Minas Gerais, Brazil, the disease has been found to have spread throughout North and South America. As regards the parasitology, it is now universally accepted that Schizotrypanum is the cause of the disease. Studies are now being made to obtain more complete data regarding insect vectors, prevalence of the disease and animal carriers of the virus. Among domestic animals, cats and dogs take the first place as carriers.

Work at the Madrid Observatory

BULLETIN 9 from the Madrid Observatory deals first of all with the photographic and visual observations of Nova Lacertæ 1936, made at the Observatory. The photographs were obtained by means of a camera of short focus used in conjunction with the Grubb photographic equatorial, which has an aperture of 16 cm. and focal length 80 cm. The method employed for determining the magnitude of the nova was by measuring the diameters of the focal images, and applying the formulæ of Charlier and Parkhurst, adopting the mean from both formulæ. Nine comparison stars of various spectral types were used, and the results are shown in Table 2, the observations extending over the period June 21–July 17, 1936. In addition to the photographic observations, about 500 visual observations were made between June 18 and July 20, the results of which are given in Table 3, and from these the colour-index was deduced. This varied according to the spectral type of comparison star; for Class $F0$ it was 0·30 and for Class $B8$ it

was $-0 \cdot 08$, and was practically zero for Class $A0$. A curve shows the results of the photographic and visual determinations of magnitudes, the photographic magnitudes being represented by circles which lie close to the visual magnitude curve.

Similar work was done with Nova Herculis 1934, the observations extending from December 16, 1934, to April 30, 1935, and the light curve of the nova between these dates is given, circles representing the photographic magnitudes as in the case of Nova Lacertæ. A maximum difference occurred about the middle of January, this difference (photographic—visual) being 0·5 mag. It was found impossible to deduce the value of the colour-index, but it is hoped that this will be done when further data are available from various scientific journals, thus enabling comparisons to be made with the work at the Observatory of Madrid.

Bulletin 10 from the Observatory deals chiefly with solar prominences observed at the University of Valencia during 1938, and is a continuation of the 1937 observations recorded in a previous issue of the bulletin (see NATURE, **151**, 405; 1943). In addition to a description of the solar spots observed in 1938, the issue contains the positions of Comets van Gent, Whipple-Bernasconi-Kulin and Whipple-Fedtke, determined from photographic observations.

Aeroplane Compass

IN *Sky and Telescope* of January 1944 there is a description of the Gyro Flux Gate Compass System, which has overcome many difficulties for air navigators. It combines the action of the flux of the earth's magnetic field with a gyroscope designed to keep it horizontal in spite of the movements of the aeroplane. It is very much more sensitive than the ordinary compass, and it can be operated close to the earth's magnetic poles, if necessary. The existence of the instrument has been revealed recently, because it is believed that some of the compasses have fallen into the hands of the enemy, though it seems certain that he cannot produce it in great quantity during the present War. A description of the instrument is given; but the technical details are too complicated to be dealt with here. Its practical utility can be judged from the fact that its reading of true compass directions and its reliability under varying conditions have contributed to reduce the number of accidents due to uncertainties in navigation.

Transmission Line Supports

IN a paper on reinforced concrete supports read recently in London by Messrs. E. C. Neate and W. F. Bowling before the Institution of Electrical Engineers, consideration is first given to previous work done in Great Britain, and this is followed by a discussion of the requirements of a reinforced-concrete transmission-line pole. Details of experimental poles are given with an analysis of the results of tests to destruction. A graphical method of design is developed, and sufficient information is provided to enable future work to be undertaken on the bases established. An expression is obtained for the deflexion of a pole under load, and it is shown that deflexion cannot be taken as a criterion for proof-test purposes. The authors discuss fabrication and erection methods, and the paper concludes with a survey of the advantages and disadvantages of the concrete pole, reference being made to a *questionnaire* issued to a number of users in Great Britain.

St. Louis Chapter of the Society of the Sigma Xi

THE St. Louis Chapter of the Society of the Sigma Xi was installed at St. Louis University on March 16 by Prof. Harlow Shapley and Prof. George A. Baitsell. Forty members and three associate members formed the petitioning group. Prof. Shapley spoke on "Co-operation in Research", and later, Prof. Peter Debye gave the Sigma Xi Lecture, "The Magnetic Approach to Absolute Zero". Chapter officers elected for the following year were Kermit Christensen (president), Charles H. Neilson (vice-president), Arthur G. Rouse (secretary) and Alfred H. Weber (treasurer).

Announcements

THE Albert Gold Medal of the Royal Society of Arts has been awarded to Sir Henry Tizard, president of Magdalen College, Oxford, and formerly rector of the Imperial College of Science and Technology, distinguished for his scientific work in the development of aircraft (see NATURE, Aug. 1, 1942, p. 148).

THE first award of a gold medal founded in memory of Dr. Bimala Churn Law by the Indian Association for the Cultivation of Science has been made to Sir Henry Dale, president of the Royal Society. The award is given for important contributions to science including medicine.

PROF. JOHN MACMURRAY, Grote professor of the philosophy of mind and logic in the University of London, has been appointed professor of moral philosophy in the University of Edinburgh in succession to Prof. A. E. Taylor.

DR. S. W. WOOLDRIDGE, reader in geography in the University of London (King's College), has been appointed to the chair of geography in the University tenable at Birkbeck College, in succession to Prof. E. G. R. Taylor.

AT the anniversary meeting of the Linnean Society of London held on May 24 the president, Mr. A. D. Cotton, delivered a presidential address, "The Megaphytic Habit in the African Tree Senecios and other Genera". The following were elected officers for the year 1944–45: *President*, Mr. A. D. Cotton; *Treasurer*, Colonel F. C. Stern; *Deputy Treasurer*, Dr. B. Barnes; *Secretaries*, Dr. B. Barnes (botany) and Dr. Malcolm A. Smith (zoology); *Members of Council*, Prof. A. J. E. Cave, Captain Cyril Diver, Dr. Edward Hindle, Mr. A. A. Pearson, Lieut.-Colonel R. B. Seymour Sewell.

LORD KEMSLEY has made a gift to the University of Sheffield to provide, during a period of seven years from its first coming into operation, an annual travelling fellowship of £400 a year. The fellowship will come into operation as soon as circumstances allow its conditions to be fulfilled. Candidates must be unmarried men and British subjects by birth holding the degree of bachelor of the University of Sheffield and who since graduation have not taken up other full-time work than study or research in a university in the United Kingdom. The main condition of tenure is that the Fellow shall actively study at first hand the ways of a good life and of thought in the country selected, and shall become efficient in speaking and reading its language. Candidates will generally be selected from the Faculty of Arts. No applications will be accepted before a date to be announced in due course by the University of Sheffield.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Vertical Section of a Coral Atoll

Recently, Captain A. G. N. Wyatt, R.N., in one of H.M. ships, visited Fadiffolu Atoll in the Maldive Islands, and opportunity was taken to run a line of soundings across the atoll and to carry it on into deep water to a distance of some 5¾ miles from the rim.

An interesting feature of this work was the control. While in sight of the islets it was, of course, possible to fix the position of the soundings by cross bearings, but it is probably the first time that such a section has been controlled by taut-wire measurement over the rim of an atoll, so that it can be stated that the depths which were recorded continuously by echo soundings show a completely accurate determination of the contour of the sea-bed from within the atoll, where depths of rather more than 20 fathoms were obtained, into deep water of more than 1,000 fathoms.

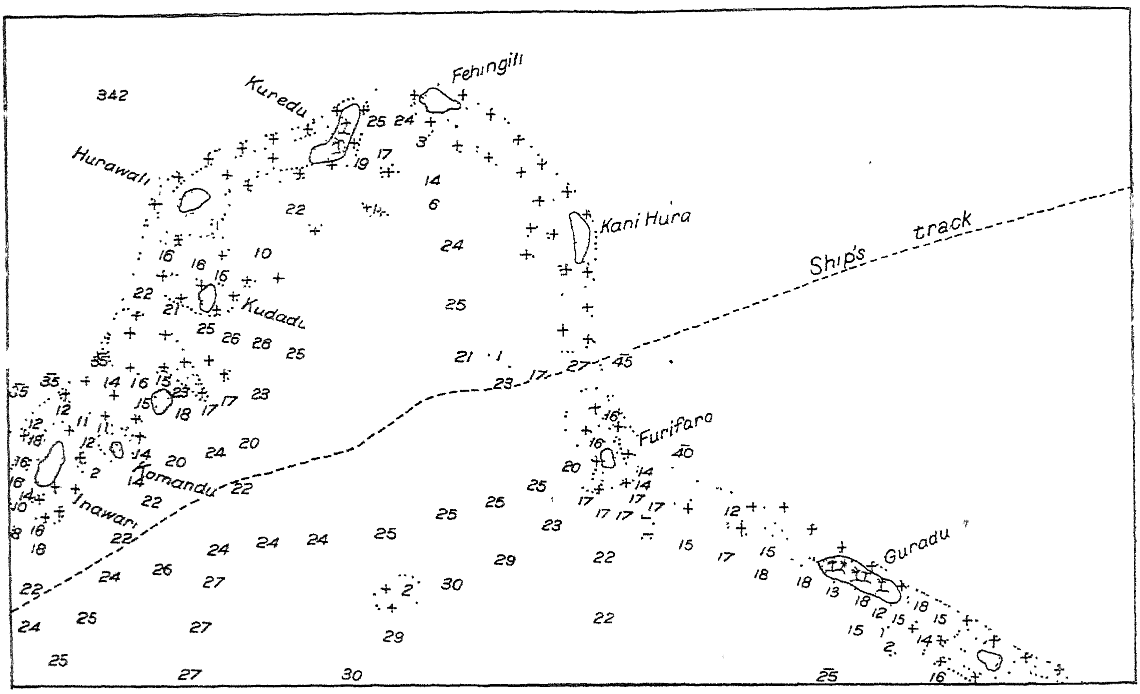
The accompanying sketch is from Admiralty Chart No. 3324, and the section below shows the form of the sea-bed.

J. A. Edgell.

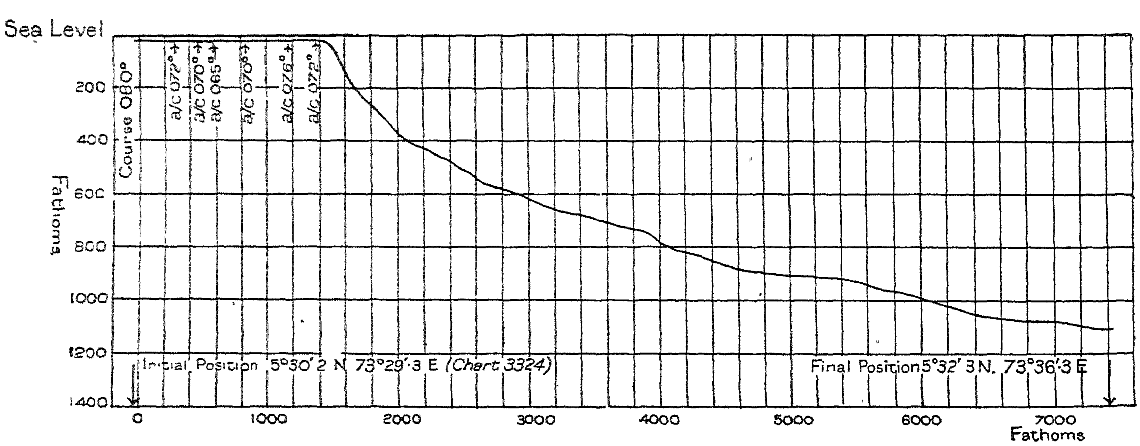
Hydrographic Department,
Admiralty, London, S.W.1.

Fatigue in Selenium Rectifier Photocells

Fatigue in selenium rectifier photocells is generally marked by a falling off in the current output, during exposure to steady radiation, of cells which have been kept for some time in darkness. The rate of decrease is greatest initially and diminishes until a practically steady current is attained after perhaps several hours. If the cell be again darkened, recovery



Maldive Islands. Fadiffolu Atoll (northern portion)



Maldive Islands. Fadiffolu Atoll. Section drawn on a line 072° through the N.E. entrance to the lagoon.

takes place. According to most investigators, recovery is a much slower process than fatigue.

Elvegard, Lindroth and Larsson[1], and more recently R. A. Houstoun[2], found that the degree of fatigue depends on the spectral quality of the radiation. They attempted no explanation of their results in terms of other properties of the cells, however. Incidental observations made at the National Physical Laboratory, during measurements of the spectral sensitivity of a number of cells, afford some new results of which a tentative explanation is possible.

It was found that: (1) When cells were exposed to radiation of wave-length greater than $0\cdot64\,\mu$ the current fell by 10 per cent in a few minutes. When the cell was afterwards darkened, recovery occurred at a similar rate. (1*a*) A few seconds exposure to overcast daylight depressed the sensitivity for wave-lengths exceeding $0\cdot64\,\mu$ by 20–25 per cent. Recovery was fairly rapid during subsequent tests with red light of comparatively low intensity. (2) With rare exceptions fatigue did not occur, or was barely detectable, with radiation of wave-lengths less than $0\cdot62\,\mu$. (3) Effects (1) and (2) were independent—exposure to light of either of the two spectral regions had no effect on the result of subsequent exposure to light of the other region.

In these experiments the cells were exposed to radiation within narrow spectrum bands (width about 100 A.). The whole of the cell surface was exposed. The resistance of the external circuit was effectively zero and the photocurrent was about 1 microamp. These conditions, and the results obtained, are not in all respects the same as in the experiments of the investigators mentioned. In particular, the photocurrent was much smaller in the present experiments. It was found, however, that the behaviour described could also be observed when the photocurrent was about 50 microamp. To show this, the cells were exposed to a tungsten lamp, signal-green and signal-red glasses being used to isolate the two spectral regions.

The behaviour described here is probably connected with the extent of penetration of the radiation into the selenium. Selenium has a fairly high transmission for wave-lengths greater than $0\cdot64\,\mu$, and is practically opaque for wave-lengths less than $0\cdot60\,\mu$. This would account for the different behaviour observed on exposure to the two spectral regions, for the photoelectric action would take place in layers situated at different depths depending on the penetration of the radiation. Moreover, we should expect the fatigue to be greatest when the action is in the deeper layers and least when only the superficial layer is concerned, the effect observed in our experiments.

The cells used in our experiments were supplied by Messrs. Evans Electroselenium, Ltd.

J. S. PRESTON.

Light Division, National Physical Laboratory, Teddington, Middlesex. March 20.

[1] *J. Opt. Soc. Amer.*, **28**, 33 (1938).
[2] *Phil. Mag.*, **31**, 498 (1941).

Mathematics of Biological Assay

BIOLOGICAL assays may be divided into two main classes. In the first, which we may call Type I, the 'potency' of the test material, as compared with that of a standard preparation, refers only to its relative ability to produce certain effects in the experimental animals, no assumptions being made as to the substance or substances responsible for the effects. An example is the testing of extracts from plants for their insecticidal power. In Type II, however—and this must now be the larger class—the response of the experimental animals is used to estimate the content, in units of some kind (which may be either of an *ad hoc* nature or actual units of weight) per unit weight of test material, of a single substance producing the response in question. Into this category fall, for example, most assays of vitamins.

My previous letter[1] on the theory of the 4-point experimental design was intended to show that the method was of both wider applicability and greater accuracy than N. T. Gridgeman[2] had assumed. I was at the time, I admit, thinking only of Type II assays. D. J. Finney has now rightly pointed out[3] that in certain assays (which, as will be seen later, must be all of Type I) the method may be quite invalid. I feel, however, that some readers might be unduly frightened off the 4-point method by Mr. Finney's letter, as much as some others might be led into unjustifiable use of it by mine. It is perhaps worth while, therefore, to consider further the criteria to be satisfied in order that the 4-point method may be valid.

All biological assays begin by being of Type I. They are transferred to the Type II group as soon as the progress of knowledge makes it plausible to assume that the responses of experimental animals dosed with the standard preparation and those dosed with the test preparation are qualitatively identical and caused by the same factor F in both preparations; and that this factor, whether chemically an element or a compound, is single in nature and uniquely responsible for the effect. This assumption must be regarded as experimentally established before the conclusion "This material is 10 times more potent than the standard", which is typical of Type I assays, can be translated into "This material contains 10 times more of the factor F than does the standard", equally typical of Type II assays. (Whether or not the further step to "This material contains U units of the factor F per gram" is made is irrelevant.) Moreover, the assumption in question is inherent in the experimental design of any normal Type II assay—in the interests of brevity the reader is left to check this point for himself.

But if the experimental response to dosage is caused by a single factor F and by nothing else, then the test and standard preparations must behave as solutions of the factor F, of different concentrations, in a biologically inert diluent; and the relation between the response Y and the log-dose X, whatever its form may be, must be the same in both cases. In fact, if the doses are measured not in terms of the weight of preparation given but in units of the factor F contained therein, all the experimental data are points on the same curve. In so far as this is not true, the translation of 'potency' into 'content of factor F' *will be in error, whether the method of assay adopted was the 4-point one or not.* In any valid Type II assay, however, there are not merely (to quote Mr. Finney) "strong *a priori* reasons for believing that the standard and test preparations have response curves of identical form"—this assumption is, as just stated, fundamental to the design of the experiment and the interpretation of the results. In such cases, the 4-point method of assay correctly estimates the relative potency of the test and standard preparations, provided that the relationship between Y and X is of the form

$$Y = a + bX + cX^2,$$

which, at least over the range of doses employed in

practice, may justifiably be assumed to be true. (Even if there are cubic and higher terms in X, the 4-point method will be in error to an extent which is insignificant compared with the irreducible error of all biological assays.)

Summing up, therefore, a 4-point method of assay is perfectly justifiable, and will give an accurate estimate of the relative potencies of two preparations, in all cases where the response of the experimental animals is assumed to be caused by a single factor present in both and to be uninfluenced by any other constituent of either. In assays in which this assumption is not made, the 4-point assay *may* still be valid if there are cogent reasons, derived from previous work, for assuming that the standard and test preparations have response curves of identical form. In all other cases, the 4-point assay is unjustifiable, will probably result in grave error, and should not be employed.

Mr. Finney has seen this letter and is in full agreement with it. He suggests, however, that attention should be directed to the desirability of so arranging the dosages that the responses to the test and standard preparations are not very different. A working rule, which provides a good factor of safety in avoiding certain possibilities of error, is to regard as only tentative any conclusions drawn from a 4-point assay unless the response to one of the two doses of the test material falls between the responses to the two doses of the standard preparation.

The conclusion of Mr. Finney's letter to me might fittingly conclude this letter also. "I think that the decision on a suitable assay procedure is mainly one for the biologist or chemist involved, not a matter of abstruse mathematical theory, and he must make this decision in the light of his experience and knowledge of the material in question."

ERIC C. WOOD.

Virol Limited,
Hanger Lane,
Ealing, W.5.

[1] Wood, E. C., NATURE, 153, 84 (1944).
[2] Gridgeman, N. T., *Biochem. J.*, 37, 127 (1943).
[3] Finney, D. J., NATURE, 153, 284 (1944).

Fluctuations in the Porosity of Egg-Shells

DURING the course of an experiment designed to study the effect of different levels of dietary calcium on various egg-shell characteristics, measurements were made of the porosity of egg-shells. Eggs were collected from twelve birds in all during a period lasting from mid-December to mid-January. At first, four birds received a high-, four a medium-, and four a low-calcium diet; later, all twelve received the medium-calcium diet. A basal ration low in calcium was used, and to this was added 8, 4 and 0 per cent of calcium carbonate to give the high-, medium- and low-calcium diets respectively.

Porosity was measured by calculating the loss in weight in milligrams per day per square centimetre of surface area under standard conditions of humidity and temperature, total surface area being calculated from Dunn's formula[1], as modified by Mueller and Scott[2]. The porosity value obtained will be referred to as the porosity coefficient.

Considering birds on the high- and on the medium-calcium diets, it was observed that in thirty-five out of forty-one clutches produced, the first egg of the clutch had a porosity coefficient less than that of any of the remaining eggs in the clutch—a clutch being here defined as a series of eggs laid on successive days, with one or more days of rest from laying between the clutches.

As examples of these variations in porosity coefficients, values for bird 2, which was first on the high- and then on the medium-calcium diet, and for bird 5, which was on the medium-calcium diet throughout, are given in Table 1.

TABLE 1.
BIRD 2.

Clutch No.	1	2	3	4	5	6	7
Days of rest before clutch	1	1	1	1	1	2	2
Porosity coefficients of successive eggs in clutch 1st	1·84	2·00	1·85	2·22	2·05	1·99*	1·82
2nd	2·67	2·49	2·28	2·35		2·22	2·37
3rd	2·21		2·38			2·38	2·55
4th	2·26					2·41	2·48
5th	2·14					2·39	2 33
6th	2·13					2·47	
7th	2·25						

BIRD 5.

Clutch No.	1	2	3	4	5	6	7
Days of rest before clutch	1	1	1	2	1	1	1
Porosity coefficients of successive eggs in clutch 1st	1·88	1·89	1·90	1·64	2 09	2·06	2·14
2nd	2·09	2·14		2·52	2·35	2·13	2·30
3rd	2·25	2·19			2·43	2·31	2·30
4th	2·32	2·41				2·19	2·27
5th						2·30	

*First egg on medium-calcium diet.

The birds on the low-calcium diet soon ceased to lay, and their calcium metabolism was profoundly disturbed, as shown by the gradual thinning of the shells and a general increase in porosity coefficients; however, even these birds displayed a similar tendency, though less pronounced, for the first egg of a clutch to have a smaller porosity coefficient than succeeding eggs of the clutch. Porosity coefficients for bird 12 are shown in Table 2.

TABLE 2.
BIRD 12.

Clutch No.		1	2	3
Days of rest before clutch		1	1	1
Porosity coefficients of successive eggs in clutch	1st	3·52	2·30	2·69
	2nd	2·36	2·78	4·36
	3rd	2·84	3·26	

It should be clearly understood that the low porosity coefficient of the first egg of a clutch is not caused by a thicker shell. A large number of shell thicknesses have been measured, and there is no indication of a relationship between shell thickness and porosity coefficients, except, as mentioned above, where shells become abnormally thin on the low-calcium diet.

Common and Hale[3], and Tyler and Willcox[4], while expressing their views somewhat differently, are in substantial agreement concerning mobilization of bone calcium by laying hens. They have suggested that the bones of laying hens have two types of calcium reserve from which the bird can draw when the calcium absorbed from the food is insufficient to provide for all the shell calcium. The more readily

mobilized reserve has a relatively high calcium–phosphorus ratio (there is evidence that the ratio, under certain conditions, may be infinitely high, that is, that calcium may be withdrawn without a corresponding withdrawal of phosphorus), while the less readily mobilized reserve has a relatively low calcium–phosphorus ratio. The chief source of bone calcium for the first egg of a clutch is the more readily available reserve, whereas the relatively less available reserve is drawn upon to a progressively greater degree for the succeeding eggs of the clutch.

It is too early yet to link up the differences in porosity with this conception of different types of bone calcium, but the possible connexion should be borne in mind when attempts are made to explain these porosity changes.

It is hoped to publish a fuller account of this work at a later date.

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Department of Agriculture,
CYRIL TYLER.
Department of Agricultural Chemistry,
The University, Reading.

[1] Dunn, L. C., *Poult. Sci*, 2, 166 (1923).
[2] Mueller, C. D., and Scott, H. M., *Poult. Sci*, 19, 163 (1940).
[3] Common, R. H., and Hale, R. W., *J. Agric. Sci.*, 31, 415 (1941).
[4] Tyler, C., and Willcox, J. S., *J. Agric. Sci.*, 32, 43 (1942).

Effects of X-Rays on Erythrocytes Irradiated *in vitro*

IRRADIATION of erythrocytes with X-rays *in vitro* causes hæmolysis. The dose of X-rays required to obtain complete hæmolysis is influenced by the concentration of the erythrocyte suspension and by the medium. A state of resistance to hæmolysis results when a dose of two million r. is given to an erythrocyte concentration of 0·1 per cent or less in normal saline[1]. The question arises, whether these erythrocytes are resistant to other hæmolysins or only to the X-rays producing this stable state.

To answer this question, experiments were undertaken in which erythrocytes made resistant to hæmolysis by X-ray irradiation were exposed to the hæmolytic effect of light and saponin respectively.

(1) Human or rabbit erythrocytes in 0·1 per cent suspensions in normal saline in hanging drops under mica slides were irradiated with doses of 2 million *r* (35 kV. 15 milliamp. copper anode 3 cm. distance). After 24 hours there was no hæmolysis. Then after addition of eosin solution to the irradiated drops and to non-irradiated control drops both were exposed to sunlight. Hæmolysis occurred in the control drops after 10–20 min., while in the X-irradiated drops no hæmolysis took place after 1–2 hours.

(2) Solutions of saponin were added in different concentrations to erythrocytes prepared and irradiated in the same manner as in the foregoing experiments. In non-irradiated control drops, addition of one drop of saponin solution (1 : 15,000) caused hæmolysis in about 5 min., while concentrations of 1 : 3,000 were not hæmolytic to the pre-irradiated erythrocytes after 24 hours.

The results of these experiments suggest that two different effects of X-rays on erythrocytes are possible, one of which causes complete hæmolysis, whereas the other, on the contrary, causes the erythrocytes to become resistant to the hæmolytic effect of X-rays, light or saponin.

Whether one or the other effect takes place depends on the concentration of the erythrocyte suspension in normal saline and the dose of X-rays. The resistance to hæmolysis fails to appear if serum is added to the normal saline or if the erythrocytes are irradiated in glucose solution.

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March 14.

[1] Halberstaedter, L., and Goldhaber, G., *Proc. Soc. Exper. Biol. and Med.*, December 1943.

Vitamin C in Plants

'Nasturtium' (*Tropaeoleum majus*)

THE nasturtium, *Tropæoleum majus*, a native of Peru, flourishes throughout New Zealand. The leaves, which are used as a salad food, are very rich in vitamin C, the concentration ranging from 200 to 465 mgm. per 100 gm. in the samples tested. As a rule, the leaves of any particular plant show much less variation than this, although small leaves tend to have higher values than large leaves. Stalks contain 100–160 mgm. per 100 gm. and are therefore also a rich source. Little or no dehydroascorbic acid is present, although the ascorbic acid oxidase is exceedingly active in disintegrated tissues.

The ascorbic acid was titrated visually in 1 per cent metaphosphoric acid extracts with dichlorophenolindophenol solution. That the reducing properties of the extract are correctly attributed to ascorbic acid is proved by the rapid enzymatic oxidation which takes place in extracts unless prevented by boiling, or addition of metaphosphoric acid, etc. Also, a 60 per cent yield of pure dinitrophenylosazone of dehydroascorbic acid was obtained from an extract made with boiling water, oxidized with iodine and treated with dinitrophenylhydrazine.

An extract for addition to the diet of babies is readily prepared by adding nasturtium leaves to boiling water until no more can be immersed, boiling three minutes longer and draining. This extract normally contains more than 150 mgm. of ascorbic acid per 100 ml., and sealed away from air is fairly stable. It has not the pungent taste of the fresh leaves, this being lost during the boiling.

The nasturtium is a particularly suitable plant for investigation of ascorbic acid distribution, synthesis, etc., and merits more detailed study.

I wish to thank Dr. Guy Chapman for the suggestion that the nasturtium should be examined for vitamin C, and also Mr. K. Griffin, Government analyst, Auckland, for his interest and encouragement.

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Iris (*Iris germanica*)

THE communications that have appeared in NATURE during the past few years in which rose hips, pine needles, etc., have been suggested as sources of vitamin C, prompt me to direct attention to the leaves of the common European iris (*Iris germanica*) as a superior material from which this vitamin can

be readily prepared in substantial quantity. Unlike fruits, the ascorbic acid of which increases as they ripen, the leaves of most plants contain the largest amount when young[1]; most of the vitamin rapidly disappears from leaves as the plants mature. With Iris, however, the ascorbic acid content of fresh undried leaves, which is 0·6 per cent in the spring, does not fall below 0·3 per cent as the season advances. Few plant materials contain as high a concentration as that found in Iris leaves even at the end of the season (at least in the vicinity of New York City). The leaves are heavy and can be cut with little injury to the root-stalks. The vitamin is separated from the gums and other substances present in press juice far more easily than from any other source we have used[2].

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March 14.

[1] Marine, D., Baumann, E. J., and Webster, B., *J. Biol. Chem.*, **89**, 213 (1930).

[2] Baumann, E. J., and Metzger, N., *Proc. Soc. Exp. Biol. and Med.*, **30**, 1268 (1933).

Indian Gooseberry (*Phyllanthus emblica*)

THE need at the moment, especially of the Fighting Forces, for vitamin C has provided the urge for establishing more natural sources rich in this vitamin. Recent search has revealed that walnut[1], rose hips[2] and parsley[3] are among the most potent. The earlier, already familiar, sources are cited in Thorpe[4]. I wish to direct attention to the existence of another rich source, namely, the Indian gooseberry, discovered more than eight years ago, but missed by subsequent workers abroad and recently rediscovered by Chen *et al.*[5], from China.

In a general investigation on the vitamin C content of Indian plant materials, undertaken by me early in 1935 at the Biochemical Laboratory, University of Madras, in collaboration with Dr. M. Damodaran (senior author), it was observed and reported that the Indian gooseberry, *Phyllanthus emblica* L., contains as much as 290–468 mgm. per cent of the vitamin[6]. According to later workers in India and in the East Indies, the vitamin content of this fruit is even higher: 540 mgm. per cent[7], 720 mgm. per cent[8] of the fresh pulp and 921 mgm. per 100 ml. of the juice[5]. In the original publication[6] it was also reported that the gooseberry fruit, unlike most other plant sources, has the merit of possessing a mechanism capable of protecting ascorbic acid from oxidation, so that the vitamin remains largely intact, even in the desiccated fruit.

The fruit, it is understood[9], is now being utilized by the Food Department of the Government of India for making edible preparations intended to meet, in some measure, the vitamin C requirements of the Indian Fighting Forces. Khan[10] has reported that the gooseberry fruit has been found very useful in the treatment of cases of human scurvy in the Hissar famine of 1939–40. History has it that an attack of scurvy in the Indian army at Nassirbad in Rajputana in 1837 was treated successfully with an extract of the dried fruits[11]. The fruit is known in Hindi as *amla* and the tree is widely distributed in India and Burma.

M. SRINIVASAN.

'Pradhan',
Poona, 4.

[1] NATURE, **150**, 267 (1942).

[2] *Biochem. J*, **36**, 336 (1942).

[3] NATURE, **152**, 92 (1942).

[4] "Dictionary of Applied Chemistry", **1**, 503 (1941).

[5] NATURE, **152**, 596 (1943).

[6] *Curr. Sci.*, **3**, 553 (1935); *Proc. Indian Acad. Sci.*, **2B**, 377 (1935).

[7] *Arch. Neerl. Physiol. de l'Homme et des Animaux*, **23**, 433 (1938).

[8] *Indian J. Med. Res.*, **26**, 165 (1938).

[9] Private communication from the Foodstuffs Directorate.

[10] *Indian Med. Gaz.*, **77**, 6 (1942).

[11] *Lancet*, **11**, 322 (1919).

Early Human Embryos

WE read with interest the short account of the nine–ten day human embryo described by Prof. Francis Davies in NATURE of April 15. This embryo is obviously of great importance and value to the study of early human development, in which such significant advances have been made in the past few years. Prof. Davies compares his specimen with the human ovum *Wi*-8004 described, in a preliminary communication, by Rock and Hertig[1], and he states that "these two ova represent the earliest specimens of fully implanted human ova yet discovered". In fairness to Drs. Hertig and Rock, who have made such valuable contributions to this field of embryology, we think it should be pointed out that one of the ova (*Mu*—8020) described by them is estimated to be 7·5 days old and is in the earliest stage of human intra-uterine development so far described. This ovum is, of course, at a very much earlier stage of development than that described by Prof. Davies. Even the next older specimen of Rock and Hertig (*Wi*—8004), the one to which Prof. Davies refers, is not, unlike Prof. Davies's specimen, completely implanted. To quote Rock and Hertig: "the defective endometrial epithelium has been partially repaired and is in the process of closing the defect created by the implanting ovum". A comparison of the photograph of Prof. Davies's specimen with the photograph of *Wi*—8004 in Rock and Hertig's communication leaves us in no doubt that the former is in a more advanced stage of development and of implantation.

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[1] Rock, J., and Hertig, A. T., *Amer. J. Obstet. Gynecol.*, **44**, 973 (1942).

Rock and Hertig[1] explicitly described their 7·5-day ovum (*Mu*—8020) as "implanted on" the endometrium; that is, this ovum has only just begun to embed itself and a large part of the ovum is still freely exposed in the uterine cavity. On the other hand, they referred to their older ova (including the 9·5-day ovum, *Wi*—8004) as "implanted within", "embedded in" the endometrium. In the limits of a short letter, I thus deliberately confined my comparison to "fully implanted" specimens, by which I mean specimens in which no part of the embryonic tissues is exposed freely to the uterine cavity. If completeness of endometrial epithelialization is to be the criterion determining whether an ovum is

fully implanted or not, then my specimen is not so far advanced *in this respect* as the *Wi*—8004 ovum, in that no surface epithelialization has yet commenced in my specimen, but the embryonic tissues are separated from the uterine cavity by the maternal fibrinous elements of the operculum. This process of epithelialization evidently takes a considerable time, since it is not complete even in the 11·5- and 12·5-day Hertig-Rock ova[2], by which time the "fully-implanted" ovum has undergone considerable advance in development beyond the stage shown in my specimen.

But such trivialities mask the important principle that the various elements in human ova of approximately the same age may show considerable differences in the stage of development which they have attained; such has been shown also in macaque embryos by Heuser and Streeter[3]. Whereas the general organization of my specimen is similar to that of the 9·5-day Rock–Hertig ovum (*Wi*—8004), some features of the latter are more developed (for example, partial surface epithelialization, two-layered endoderm), and some are less developed (for example, total size of ovum, thickness of trophoblast) than in my specimen. I have discussed the above points fully in a paper I have submitted for publication elsewhere.

I therefore still maintain that "these two ova represent the earliest specimens of fully implanted human ova yet discovered", and that the detailed differences between them are compatible with their being approximately the same age. I naturally share the admiration of Profs. Hamilton and Boyd for the work of Rock and Hertig.

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[1] Rock, J., and Hertig, A. T., *Amer. J. Obstet. Gynecol.*, **44**, 973 (1942).
[2] Hertig, A. T., and Rock, J., Contrib. Embryol. Carnegie Inst. Wash., **29**, No. 184, 127 (1941).
[3] Heuser, C. H., and Streeter, G. L., Contrib. Embryol. Carnegie Inst. Wash., **29**, No. 181, 15 (1941).

Display and Bower-building in Bower-birds

AN investigation was carried out on the fairly typical bower-bird, *Ptilinorhynchus violaceus*, during 1939–41 in the Zoology Department of the University of Sydney and in rain-forests of eastern Australia. A full report of the investigation is at present in the Fisher Library in the University. The War having interfered with publication, the general conclusions reached are summarized below.

(1) The annual cycle of display and bower-building is dependent on the gonads and is stimulated by the same environmental factors that initiate actual breeding in other birds of the locality. Increasing light may be the principal stimulus; food and temperature have nothing to do with it.

(2) The male has already selected, or has been selected by, his mate when he arrives at his bower-territory after leaving the off-season feeding-flock in July. Thus bowers and decorations have little to do with sexual selection, which may have taken place during the winter flocking. It seems that the primary function of display and its associated specializations (bower, colour, 'decorations', noise, etc.) is to stimulate male and female reproductive systems as a prelude to successful fertilization. It is probable that external stimuli from the bower, etc., pass through visual and auditory receptors to the central nervous system and thence through the anterior pituitary to the gonads. Gonadectomy inhibits bower-construction and display. (Attempts to remove the anterior pituitary ended fatally.)

(3) Display and decoration of the bower begin in July–August: it is not until September–October that nesting begins.

(4) In the selection of its coloured 'decorations' or playthings the male Ptilinorhynchus closely matches the colours, especially the conspicuous epigamic features, of the female. During male display the female takes little or no active part—she may be absent or impassively present. The male's colour choices (blue, lemon-yellow and grey-brown) may serve the function of exciting himself by their resemblance to female colours.

(5) Some male birds paint or plaster the inner walls of their bowers with fruit-pulp, macerated wood or charcoal and other substances. The habit of painting coincides with that of breeding and not that of display.

(6) At least one species of bower-bird (Ptilinorhynchus), probably a second (*Chlamydera cerviniventris*) and possibly a third orientate their bowers across the sun's path.

(7) When the female leaves the bower-territory in September–October, she alone begins nidification and incubation, often in a part of the forest distant from the bower. The male continues his display without an audience and with undiminished vigour. This continues almost without interruption until January, when the female and her young arrive at the bower and a communal display takes place. In a few weeks, or days, the bower is deserted or wrecked, and the family party joins one of the large gregarious feeding flocks which are moving noisily through the fruit-bearing trees of the forest. In these flocks, numbering from ten to a hundred, a minor form of display is constantly taking place. The family parties are broken up in the feeding flocks.

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A Simple Technique for Photomicrography

DR. LEAK's article in NATURE of May 6 has interested me very much; it describes a procedure which I think I was responsible for 35 years ago when I was working at Santa Elena in Entre Rios, Argentina.

I had an early Leitz microscope, and was interested in Texas cattle fever, blackwater and other trypanosome diseases. I had a good Kodak camera, and I also had a very early Kodak 'Brownie' camera making pictures on roll film about 2¼ in. by 2¼ in.—price 5*s*.—without view-finder. This little camera was so small and easily balanced that I found it unnecessary to do more than set up the microscope with the optical axis vertical, focus the object as for ocular observation as accurately as might be, and simply place the camera on the eyepiece, which was large enough to hold it quite safely without any other support, centring the lens by judgment and opening the shutter as smoothly as I could. I used a Welsbach mantle gas burner for the illumination.

Most of the pictures I took at that time were equal to anything I have taken since, even with very much more elaborate and expensive equipment. Unfortunately, I have preserved no prints or films.

J. LEONARD BOWEN.

9 The Wiend, Bebington,
Cheshire. May 8.

EFFECTS OF CARBON DIOXIDE ON THE HEART AND CIRCULATION

In his presidential address to the Physiology Section of the thirty-first Indian Science Congress held in January, Dr. S. N. Mathur discussed the physiological importance of carbon dioxide. Carbon dioxide has generally been regarded as a toxic waste product which the body seeks to eliminate as rapidly as possible, but it is now well recognized that it has certain beneficial actions as well. Originally a necessary evil, it has, in the course of evolution, so inextricably worked its way into the body machinery that it has come to be indispensable for certain physiological processes. The necessity of carbon dioxide for maintaining the *p*H of the blood and the activity of the respiratory centre is, of course, well known; its importance for the proper working of the cardio-vascular system is less well appreciated, and this field, in which Dr. Mathur has made important observations, may be worth a brief review.

The fundamental experiments have been made on anæsthetized cats and dogs. The carbon dioxide content of the blood was increased by inhalation of carbon dioxide and decreased by forced breathing (hyperventilation). The most striking effect is on the arterial blood pressure, increase of carbon dioxide causing a rise of pressure, decrease a fall. This effect is due to the direct action of carbon dioxide on the vasomotor centre, the normal 'tone' of which is dependent on the continual stimulus of carbon dioxide. In addition, carbon dioxide has a peripheral action on the capillaries causing dilatation, which tends to cause a fall of blood pressure; normally, however, the central effect predominates and the net result is a rise.

In anæsthetized animals, increase of carbon dioxide causes slowing of the heart (sometimes there is a transitory initial acceleration). The slowing is partly reflex from the rise of blood pressure, but is mainly due to the direct action of carbon dioxide on the cardio-inhibitory centre. Conversely, hyperventilation causes acceleration of the heart.

Increase of carbon dioxide causes a considerable increase in the stroke volume of the heart, so that, despite the reduced heart-rate, the total output per minute is increased. The increase in stroke volume is due to increased diastolic filling, and it was thought that this was simply due to the rise of venous pressure which usually occurs. Dr. Mathur has shown, however, that the increase in cardiac output can occur quite independently of the rise of venous pressure, and he believes that carbon dioxide has a direct action on the heart-muscle, increasing the diastolic relaxation of the ventricle. When the carbon dioxide is reduced by hyperventilation, the cardiac output falls owing to reduced diastolic relaxation of the ventricle. He emphasizes this beneficial action of carbon dioxide on the heart in promoting diastolic relaxation and so allowing greater filling, which, owing to the intrinsic properties of cardiac muscle, automatically gives rise to increased output. He believes, further, that this increased cardiac output is an important contributory factor to the rise of blood pressure.

Previous workers had usually reported a reduction of cardiac output following administration of carbon dioxide. Dr. Mathur found that the increase of output with carbon dioxide was only to be obtained during the first hour or two of the experiment, while the heart was 'fresh'; after several hours of anæsthesia, the heart became 'stale' and then carbon dioxide caused a reduction of output. This seems to explain the discrepancies in the reported results. It seems rather surprising that an increase of carbon dioxide above the normal level should actually improve the efficiency of the heart. The general outcome, however, is quite clear, that a normal level of carbon dioxide in the blood is necessary for the maintenance of normal vasomotor tone, normal heart-rate and normal diastolic relaxation of the heart; these must all be reckoned as beneficial effects.

The general interpretation of these cardio-vascular responses to an increase of carbon dioxide is that the circulation-rate is increased in order to hasten removal of carbon dioxide. The slowing of the heart is, therefore, somewhat surprising; an acceleration would seem more appropriate. Dr. Mathur regards the slowing as a protective device, enabling the heart to conserve its energy so that it can survive longer under asphyxial conditions. It remains to be seen, however, if the slowing is a general phenomenon; perhaps it only occurs under anæsthesia. In man, inhalation of carbon dioxide always causes acceleration. In the whole animal the problem is complicated by the fact that the increased respiratory movements cause changes in the venous return which reflexly affect the heart-rate and the output. It is very difficult to disentangle these effects from the direct effects of carbon dioxide, and the whole problem requires further analysis. O. A. TROWELL.

ECONOMIC EXPLOITATION OF EUROPE AND ITS CONSEQUENCES

The analysis of German economic policy for Europe which was issued by the Royal Institute of International Affairs in March 1941 under the title "Europe Under Hitler: In Prospect and Practice" has now been followed by a further study, "Occupied Europe: German Exploitation and its Post-war Consequences"*. The measure of the change in the situation during the three years may be seen in the structure of the two booklets. The first emphasized the two parts of German economic policy: a short-term plan for the duration of the War; and a long-term plan for the permanent organization of Europe. The first booklet discussed both, but while the first part of the new study examines Germany's domination over occupied Europe and the mobilization and exploitation of its resources up to the autumn of 1943, the implications of a permanent German 'New Order' are no longer considered. Instead, the second part dealing with the post-war period discusses some of the problems to be faced during and after liberation, and in a couple of dozen pages gives a lucid account of the implications of German domination and the conditions which any plans for rehabilitation and reconstruction must seek to meet.

The first part of the booklet points out that, whether by military or political measures, the Germans have bereft all the occupied countries of their freedom. All resources, both material and human, have been mobilized for the benefit of Germany and often transferred to Germany, while under the

* "Occupied Europe: German Exploitation and its Post-War Consequences. Pp. 75. (London: Royal Institute of International Affairs, 1943.) 1*s*. 6*d*

blockade and war conditions, even the neutral countries can only maintain their economic life by diverting a high proportion of their normal trade to Germany or to countries under her domination. Sweden, for example, is now entirely dependent for supplies of coal, and for many other commodities, on imports from Germany, and in return continues to export to the Reich high-grade iron ore and other materials urgently required for the German war economy. Continental Europe has been taking about two-thirds of Sweden's export trade, of which Germany receives some half. Again, Germany has been forced by events to concentrate more on short-term plans for the mobilization of resources for their immediate effect than on long-term policy for the 'New Order', and the factors which govern the economic policy for any territory are the current requirements of the German war machine and the need for the maintenance and security of the German home front.

The fundamental difficulty in Germany's war economy problems is a shortage of man-power. The social and industrial consequences of the German exploitation of the human and material resources of the occupied countries, and the resultant food situation, need only to be pondered to realize how grave are the implications for the post-war period. The pamphlet, however, also directs attention to the enormous demand for fuel and power created by Germany's war economy, together with the shortages resulting from the British blockade of overseas supplies of oil and also raw materials. The extensive development of substitute raw materials and the power requirements of industry, as well as the demands of transport and the armed forces, have placed a tremendous burden on available supplies of coal, wood and electricity. The manufacture of substitutes is estimated to demand a third of the total output of electricity in the Reich and about one-fifth of the output of coal. Moreover, while Germany has gained control of all the main sources of coal in Europe, she has apparently been unable appreciably to increase production. The whole transport system under the control of Germany is now suffering from severe strain, motor transport has had to be cut to the barest minimum, sabotage is an increasingly important element and the railways of occupied Europe are being taxed and drained to the limit regardless of ultimate or immediate deterioration.

Agricultural production is being adjusted to serve Germany's special needs, with compulsory delivery at stable prices and the control of harvesting, enforced by heavy penalties. The long-term policy has attempted to increase production in the low-yield areas with adjustment in Western countries in consequence of the shortage of feeding stuffs, which has involved a compulsory decrease in draught animals, cattle, pigs, and other livestock. This policy has not conduced to willing co-operation from farmers in the Scandinavian countries and the Netherlands, and many factors have operated against the policy of increasing the production of oil seeds in south-eastern Europe. Improved weather conditions in 1943 more than compensated for shortage of labour, fertilizers and equipment. The yields of crops increased and the position as regards vegetable oils improved. With regard to industrial raw materials, in spite of the opening of mines and exploitation of resources, the lack of certain raw materials is still a problem which must be intensified by the loss of the manganese resources at Nikopol and bombing policy in the west, with the destruction of molybdenum mines in Norway, for example. In the U.S.S.R. the withdrawal of practically all skilled labour by the Russians, and their 'scorched earth' policy, made it difficult for the Nazis to execute plans for rapid economic development, and apart from manganese the gain in raw materials appears to have been small.

The review of the mechanism of economic exploitation adopted by the Germans in accordance with their policy of organizing the maximum development of essentials in their own interests draws largely on the Inter-Allied Information Committee's report, "The Penetration of German Capital into Europe". It is, however, well that it should be widely realized that as the occupied areas are released from enslavement they will be faced not only with conditions of starvation, destitution and probably, in consequence, disease, far more widespread and acute than in 1918–19, but also, in consequence of this exploitation, with far-reaching disintegration and breakdown of their national economies. Unless the British and American peoples fully understand the position, they can scarcely be expected to make the sacrifices that will be involved in their own standard of living.

While it is difficult to forecast the dimension or order of the problem of relief and rehabilitation, the second part of this booklet at least gives a succinct account of the immediate needs which the United Nations Relief and Rehabilitation Administration and similar bodies will have to face, whether the release of occupied areas is gradual or the collapse of Germany sudden. Detailed planning of long-term reconstruction has as yet only reached the stage of initial discussion and investigation, though the pamphlet gives some indication of the factors that may determine it—the development of synthetic and substitute materials, of hydro-electric power and transport, agricultural policy and adjustments; but the provision of relief and rehabilitation will be, as Sir Frederick Leith-Ross has pointed out, the test of the capacity of the United Nations to rebuild a more prosperous world and to give freedom from want in their territories. The Royal Institute of International Affairs in this pamphlet has done something to make plain what this will involve in terms of the continuance in the immediate post-war period of the shortages and rationing, controls and restrictions of war-time.

THE NUCLEOLUS

THE nucleolus was first figured in 1781 as a spot in the centre of a round or oval body (the nucleus) in epithelial cells of the eel. Since then it has been described in the nuclei of almost every type of plant and animal cell. Many interpretations were offered of its nature and function. Perhaps the view most widely accepted until very recent years was that it acted as a focus for the elaboration of chromatin which passed from it to the chromosomes as they developed through the prophase. During the last decade the use of Feulgen's reaction for the staining of nuclei has given a new impetus to the study of the nucleolus. This stain showed that at no stage does the nucleolus contain chromatin. Feulgen's stain, together with other modern cytological methods, has made possible the tracing of nucleolar behaviour through all stages of the mitotic and meiotic cycles, and has led to entirely new interpretations of the

role of the nucleolus. Most of the recent work has been done on plant cells. Although it is essential that much more attention be given to the nucleoli of animal nuclei, sufficient has been accomplished to show that plant and animal nucleoli are similar in essentials.

Three important discoveries during this century have determined the trend of modern research on the nucleolus. In 1912 were first seen, in Galtonia, chromosomes with satellites to which the nucleolus was connected. In 1926, the discovery in meiosis of Lathyrus of the 'nucleolar body' established a definite connexion between the chromosomes and the nucleolus. This body was a globule within the nucleolus to which the 'continuous spireme' was attached in prophase. With the methods then in use chromatin thread and nucleolar body stained similarly. In 1934, it was found that a 'nucleolar organizer' existed at a fixed point on certain chromosomes of maize. It was not of necessity visible as a separate entity but the nucleolus always arose in telophase at this point.

It is now well established that nucleoli are produced from the chromosomes in the telophase of mitosis. Each nucleus contains at least one pair of nucleolar chromosomes and each of the pair produces a nucleolus. The nucleolar chromosomes are frequently the sex chromosomes. Each of the pair has attached to it, by a very fine thread, a satellite which may be exceedingly small or may be a globular body as wide as the chromosome. The nucleolar organizer is usually at the tip of the chromosome at the point of attachment of the satellite thread; but it may be placed farther back at a secondary constriction. Suitable technique shows the origin of the nucleolus to consist of two minute granules, one on each strand, which stain similarly to the chromosome sheath. They may be formed from the material of this sheath, for it disappears as the granules increase in size. Any two nucleoli which touch because of growth or due to chromosome movement within the nucleus merge together. By the following prophase all are usually fused into a single body to which all the nucleolar chromosomes for some time remain attached. They break away when the nuclear membrane breaks down in late prophase and the nucleolus passes into the cytoplasm and disappears. A previous decrease in size of the nucleolus suggests that it may contribute material to the sheaths of the newly differentiated chromosomes.

The presence of several nucleoli at telophase, all of which fuse into one body before prophase, has been frequently described, but only recently has it been realized that the number of nucleoli is constant within any one species and is probably of as great phylogenetic importance as the number of chromosomes. Diploids may have one or more pairs of nucleolar chromosomes, and primary and secondary polyploids show a corresponding increase in their numbers of nucleoli countable in early telophase.

So much data on the nucleolus has accumulated that, although he gives eight pages of references, in his monograph "Nucleoli and Related Nuclear Structures"*, Prof. R. Ruggles Gates is able to quote only the more important work. Much of the earlier research obviously needs amplification or repetition using more modern technique. Gates deals briefly with the historical aspects of the subject, and then ably summarizes and critically reviews the more important recent work. As well as discussing the nucleolar cycle in mitosis in the normal higher organism, he discusses and brings into line the nucleolar behaviour in some lower organisms, he tells of related structures induced by pathological conditions and also discusses nucleolar budding. He refers to variations in nucleolar size due to physiological and other causes and evaluates the work on the chemical composition of nucleoli, much of which is at present inconclusive. He examines the relationships of the nucleoli with the chromosomes, the satellites and satellite threads. Gates suggests that the nucleolus may be of genetic and developmental significance for, after being in intimate association with genic material, at metaphase a large part of it is dissolved into the cytoplasm. Finally, he stresses the phylogenetic importance of the numbers of nucleoli, asking that future reports of chromosome numbers should include a determination of the number of chromosomes with satellites or secondary constrictions and the number and sizes of the nucleoli in somatic telophase.

F. M. L. SHEFFIELD.

* Gates, R. Ruggles, "Nucleoli and Related Nuclear Structures" *Bot. Rev.*, 8, 337 (1942).

THE HYGIENE OF THE EIGHTH ARMY IN NORTH AFRICA

LIEUT.-COLONEL H. S. GEAR, of the South African Medical Corps, has described the hygiene aspects of the El Alamein victory won by the Eighth Army in North Africa (*Brit. Med. J.*, March 18, 1944). "The Germans," says Colonel Gear, "must regretfully realize that their neglect" of sanitation "contributed seriously" to their defeat. Some 40–50 per cent of the German and Italian front-line troops were suffering from dysentery and diarrhœa, while the Eighth Army, thanks to the efficient methods outlined by Colonel Gear, was "probably as fit mentally and physically as any army has ever been".

The supply of rations to such an army, and of purified water to the quantity, during the preparatory phases at any rate, of one gallon a day for every man, must have been tremendous problems in themselves. The battle ration was reorganized, but, when the advance began, the rapid movement and dispersal of units created serious problems of cooking and refuse disposal. Each vehicle adopted the practice of preparing its own meals, a practice which resulted in feeding out of tins, waste of rations and the scattering of food remains over large areas, with the resultant encouragement of the breeding of flies. Mobile cooking lorries were therefore instituted, which carried hot, properly cooked meals forward to fighting men. It was found that continuous training and propaganda were necessary to ensure that all units had good cooks, proper company cooking arrangements and a sense of cooking hygiene and sanitation.

The water supply is always a vitally important problem of war in what Colonel Gear modestly calls "warm climates", because so many water-borne diseases exist which can rapidly destroy the efficiency of any force. El Alamein was supplied by water pipes laid from Alexandria by British Army engineers. These carried purified water for fifty miles into the desert and to points within a few miles of the front line. This was truly a remarkable feat. But, when this supply was left behind, the captured water points, polluted by the enemy with oil, dead bodies and filth of all kinds, had to be made fit for

use. When these in their turn were left behind, water was carried in tins and captured enemy water-containers. Older men who experienced the chlorinated water of the War of 1914–18 will realize what lies behind the sober account of these vital matters given by Colonel Gear. They will also be interested to hear that the sun topee was abandoned without bad results. Perhaps they will remember the friends who visited their Mesopotamian messes and next day were dead from the sudden 'effects of heat'. They will be glad to hear that no cases of heat- or sun-stroke or of other direct effects of heat were reported in the Western Desert. Even the tanks did not require special air-conditioning devices to protect their occupants from the effects of heat. Sun-glasses were not a general issue to the troops and Colonel Gear argues that they may actually be harmful, because people who get used to them in the relatively non-glaring atmosphere of, say, Cairo, may suffer intensely when they go to the white sand areas of the Western Desert.

It is a well-deserved tribute that Colonel Gear pays to the hygiene officers and men of the Eighth Army. Their work was not dramatic. Its daily details involved matters to which many adopt an ostrich attitude; it was hard slogging against difficulties which can only be overcome by meticulous attention to detail and insistence on discipline. Apart from the maintenance of efficient sanitation among the British forces, the Hygiene Corps had to supervise the Bedouin and other peoples who fled to El Alamein and became such a sanitary danger behind the British lines that they had to be removed. They were faced, like their predecessors at Mosul and other places on the Tigris during 1914–18, with the task of cleaning up the gigantic heaps of refuse and filth left behind by the retreating enemy. But they had the advantage of wise direction and an efficient sanitary organization.

It is time that a just tribute be paid to these men, who guarded, by their unremitting care, the lives and health of the fighters who saved Egypt and India. Without them the British armies might have suffered the fate of the Germans and Italians. Like the Royal Army Service Corps, the Royal Army Ordnance Corps and all the other supply services, the Hygiene Corps provided an essential part of that basis of efficiency without which the best of fighting men cannot succeed. G. LAPAGE.

FOREST PRODUCTS

ATTENTION has been directed in NATURE from time to time to the value and possible changes in the form of utilization of timber which plywood, one of the processes of lamination, renders possible. In an address before the Royal Society of Arts entitled "Forest Products", delivered on November 2, 1943, Mr. W. A. Robertson, director of the Forest Products Research Laboratory, dealt with the results of research and the future possibilities (*J. Roy. Soc. Arts*, **92**, Jan. 21, 1944). Great Britain will have to depend for its supplies of soft woods on itself (a negligible factor for some years to come), the Continent of Europe and on Canada.

As regards the forests of the British Empire, with the exception of Canada and Newfoundland the bulk lie in the tropics or sub-tropics, starting in the west with British Honduras and Guiana, on to the Gold Coast and Nigeria, thence through Uganda, Kenya, Tanganyika across to India, Burma and Malaya, and one large forest block in the south of Australia. The total area of these tropical forests is very large. The present area accessible to exploitation is estimated at 330,000 sq. miles, which is less than the area of soft-wood forests in Canada (more than 550,000 sq. miles). The two types are not comparable. Whereas the softwood coniferous forests are mostly pure (that is, of one species only) or at most two or three, in the tropical forests hardwoods prevail; species occur of varying degrees of hardness from very soft to the hardness of iron, and thirty or more species may be mixed together in a forest. To date but a few species have been in demand in Great Britain, and only a slightly larger number by the inhabitants of the countries in which the forests exist. Difficulties of commercial extraction under such conditions can be appreciated, also the failure to develop new markets owing to the mistaken policy of past administrations in insisting that the habits of the population, whether harmful to the forests and countryside generally and to a progressive development of the people concerned, should not be interfered with.

So far as difficulties of extraction are concerned, Mr. Robertson points out that the change is coming and that the new methods of use should permit of a much larger utilization. The first stage, he points out, is the change in the introduction of lamination usually associated with the term 'plywood' though, he says, lamination means much more than this. He explains it as follows in popular terms: "By the application of lamination we give up having to rely on the properties of chunks of timber as nature has given it to us with many defects and difficulties, and by arranging the timber in layers we balance defects with clear timber, we set off the weakness of timber in one direction by its strength in another and reduce the dimensional changes, i.e., the shrinkage and swelling. Thus a beam of 6″ × 3″ made up of ½ inch thick laminations can be about twice as strong as the same section cut out of solid timber of the same quality and a sheet of 3-plywood is 1½ times as strong in shear as a board of the same thickness, while its shrinkage and expansion is only one-thirteenth of the plain wood across the grain".

The possible methods of utilization thus opened out will permit of the elimination in some cases, or the distribution in others, of inevitable defects, so that they shall not occur at places of maximum stress where their weakening effect would be most felt. It may be pointed out that the application of this contention is not universal, as the oak timbers in the roof of Westminster Hall and many churches and old barns in the south of England will prove. But it is beyond dispute that with the ever-increasing demand for timber products, the new methods will permit of the use of lower quality timber "in the lightly stressed parts of an assemblage and reserve the best quality for the highly stressed regions". Finally, it permits of the utilization of short lengths of timber, the most fruitful source of waste in the past. As Robertson says, it is no secret that lamination has allowed the survival of the wooden aircraft, for without it the spars of the necessary length would have been unprocurable. Finally, it is pointed out that between 1932 and 1937 the imports of plywood into Great Britain increased from roughly 5 million cubic feet a year to 13 million, and that several of the main producing countries had reached the limits of their home-grown resources; the importance of

this change in the use of wood is therefore self-evident. The more so, as has already been pointed out in NATURE, that it should enable secondary industries to be developed on the countryside in the Colonies.

Mr. Robertson also dealt briefly with the possibilities opening out in the chemical utilization of wood, in which considerable investigations have been carried out in America.

FORTHCOMING EVENTS

Monday, June 5

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 8 p.m.—Mr. J. A. Steers: "Coastal Preservation and Planning".

Wednesday, June 7

PHYSICAL SOCIETY (COLOUR GROUP) (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 4.30 p.m.—Dr. W. D. Wright: "The Munsell System: a Review of Recent Work carried out by a Sub-Committee of the Optical Society of America on the Spacing of the Munsell Colours".

Friday, June 9

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Harold Spencer Jones, F.R.S., and Mr. R. T. Cullen: "Preliminary Results of Tests of and Observations with the Reversible Transit Circle of the Royal Observatory, Greenwich"; Sir Arthur Eddington, F.R.S.: "The Recession-Constant of the Galaxies".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. Michael Graham: "Men and Science in the Sea Fisheries".

Saturday, June 10

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Some Aspects of High Vacuum Technique, viz., High Vacuum Gauges and Glass Manipulation" (to be opened by Dr. M. Pirani and Dr. B. P. Dudding).

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

GRADUATE to take SCIENCE, TECHNICAL DRAWING and MATHEMATICS in the Newcastle Junior Technical School of Building Crafts—The Director of Education, City Education Office, Northumberland Road, Newcastle upon Tyne, 2 (June 8).

ASSISTANT MASTER qualified to teach PRACTICAL PLANE and SOLID GEOMETRY for Engineering and Building Courses in the Plymouth Junior Technical School for Boys—The Director of Education, Education Offices, Cobourg Street, Plymouth (June 8).

LECTURER (man or woman) IN GEOGRAPHY AND MATHEMATICS—The Principal, Dudley and Staffs. Technical College, Dudley (June 9).

ASSISTANT LECTURER (temporary) IN MATHEMATICS, and an ASSISTANT LECTURER (temporary) IN GEOGRAPHY—The Secretary, King's College, Strand, London, W.C.2 (June 9).

DEMONSTRATOR (man or woman) IN THE PHYSIOLOGY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, Brunswick Square, London, W.C.1 (June 9).

ENGINEER AND MANAGER of the Manchester Waterworks Department—The Secretary, Waterworks Department, Town Hall, Manchester 2 (June 10).

INSPECTORS (temporary) by the Board of Education (1) MECHANICAL OR ELECTRICAL ENGINEERING (Reference No. C.2125A), (2) AERONAUTICAL ENGINEERING (Reference No. C.2124A)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (June 10).

TEACHERS (two, temporary) with qualifications in MATHEMATICS and PHYSICS for Service Training Courses (approximately Intermediate Science standard)—The Clerk to the Governors, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17 (June 10).

OFFICER WITH THE TECHNICAL DEVELOPMENT COMMITTEE of the Holland War Agricultural Executive Committee—The Principal and Executive Officer, Agricultural Institute, Kirton, Boston, Lincs. (June 10).

GRADUATE ASSISTANT IN ENGINEERING (full-time) at the Llanelly Mining and Technical Institute and Junior Technical School—The Director of Education, Education Department, County Hall, The Castle, Carmarthen (June 10).

ASSISTANT MASTER (Graduate or non-Graduate) with special qualifications in BUILDING SUBJECTS, MATHEMATICS and SCIENCE, at the Hinckley Technical College—The Director of Education, County Education Office, Grey Friars, Leicester (June 10).

LECTURERS to take the following subjects for Evening Classes up to Matriculation standard: ELEMENTARY MATHEMATICS, GEOGRAPHY, CHEMISTRY, PHYSICS, BIOLOGY, LOGIC—The Director of Education, The Polytechnic, Regent Street, London, W.1 (June 12).

SENIOR LECTURER IN BIOLOGY—The Clerk to the Governors, South East Essex Technical College and School of Art, Longbridge Road, Dagenham, Essex (June 12).

GRADUATE ASSISTANT FOR CHEMISTRY AND MATHEMATICS at the School of Building of the East Ham Technical College—The Secretary for Education, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E 6 (June 12).

TEACHER (woman, full-time) OF HOUSEHOLD SCIENCE AND HYGIENE in the Domestic Sections of the Day Trade School and in Part-time Day Classes of the Cambridgeshire Technical School—The Education Secretary, Shire Hall, Cambridge (June 12).

LECTURER IN PSYCHOLOGY AND PRINCIPLES OF EDUCATION—The Principal, Gipsy Hill Training College, at Bankfield, Bingley, Yorks. (June 12).

DOCKYARD MANAGERS for service in the Sudan (must be fully trained Marine Engineers holding University engineering degrees, or A.M.I.Mech.E. or A.M.I.N.A.)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2148A) (June 14).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

ASSISTANT HYDROGRAPHIC SURVEYORS by the Kenya Government Public Works Department—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.904A) (June 17).

ENTOMOLOGISTS in the Medical Department of Uganda, Northern Rhodesia, and the Tanganyika Territory, for general entomological work, with special emphasis on the investigation of tsetse fly and mosquito problems in the field as well as in the laboratory—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2421A) (June 17).

HEAD OF THE PHARMACY DEPARTMENT—The Registrar, Technical College, Sunderland (June 17).

INSTRUCTOR IN PRODUCTION ENGINEERING—The Registrar, Technical College, Sunderland (June 17).

LECTURER IN ENGINEERING in West Africa—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.836A) (June 21).

PHYSICIST for essential War work (work would include experience in various research departments of a North London firm specializing in optical instruments for scientific and industrial research and control)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.518XA) (June 21).

COMBUSTION AND RESEARCH ENGINEER by large organization, with headquarters at Glasgow—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2031XA) (July 1).

ASSISTANT LECTURER IN ENGINEERING—The Registrar, The University, Manchester 13 (July 1).

ASSISTANT MECHANICAL ENGINEER for the electrical branch of the Nigerian Government Public Works Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1931).

TEACHER OF SCIENCE (particularly CHEMISTRY) AND MATHEMATICS, and a TEACHER OF MATHEMATICS AND ENGINEERING SUBJECTS, at the Slough Junior Technical and Commercial School—The Secretary for Education, County Offices, Aylesbury, Bucks.

LECTURER (man or woman, temporary) FOR PHARMACEUTICAL SUBJECTS to Ph.C. standard—The Principal, Birmingham Central Technical College, Suffolk Street, Birmingham 1.

LECTURER IN GEOGRAPHY—The Registrar, The University, Reading.

MATHEMATICAL MASTER OR MISTRESS—The Acting Headmaster, Perse School, Cambridge.

LECTURER IN GEOGRAPHY (Honours Degree and special interest in human side of Geography essential)—The Principal, Furzedown Training College, at 29 Corbett Road, Cathays Park, Cardiff.

LECTURER (full-time) IN MECHANICAL ENGINEERING, and a MASTER to teach SCIENCE and MATHEMATICS in the Junior Technical School for Boys—The Principal, Wimbledon Technical College, Gladstone Road, Wimbledon, London, S.W.19.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institution of Electrical Engineers. Report of the Council for the Year 1943–1944, presented at the Annual General Meeting on the 11th May 1944. Pp. 12. (London: Institution of Electrical Engineers.) [45

Board of Education. Principles of Government in Maintained Secondary Schools. (Cmd. 6523.) Pp. 10. (London: H.M. Stationery Office.) 2*d.* net. [55

Scientists and Production. Pp. 8. (London: Association of Scientific Workers.) 3*d.*

Report on the Work of the National Organisers of the Association of Scientific Workers. Pp 16. (London: Association of Scientific Workers.) [55

Other Countries

Transactions of the San Diego Society of Natural History. Vol. 9, No. 34: Foraminifera from the Type Area of the Kreyenhagen Shale of California. By J. A. Cushman and S. S. Siegfus. Pp. 385–426 + plates 14–19. Vol. 9, No. 35: Two New Wrens and a New Jay from Lower California, Mexico. By Laurence M. Huey. Pp. 427–434. Vol. 9, No. 36: A New Race of the Rusty Sparrow from North Central Sonora, Mexico. By A. J. van Rossem. Pp. 435–436. Vol. 9, No. 37: A New Flea of the Genus Ceratophyllus. By G. F. Augustson. Pp. 437–438. Vol. 9, No. 38: A Pleistocene Tortoise from the McKittrick Asphalt. By Loye Miller. Pp. 439–442. (San Diego, Calif.: San Diego Society of Natural History.) [124

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PROGRESS TO PARTNERSHIP IN COLONIAL DEVELOPMENT

THE value of the Middle East Supply Centre and its potentialities have recently been discussed in these columns, and the contribution which regionalism might make to the solution of colonial problems in the field of welfare and economics appears to be gaining wider appreciation. Nevertheless, there has recently been disturbing evidence of unilateralism, and absence of forethought or of desire to co-ordinate American policy with that of Great Britain in the area which the Centre covers. The essential point is well made in an article entitled "Caribbean Laboratory" by Mr. J. M. Jones in the February issue of the American periodical *Fortune*. Colonial Powers, Mr. Jones observes, must now accept the increasing and legitimate interest of other nations in the welfare of dependent peoples; Americans must learn that helping other nations is not merely a matter of spending money and giving self-government, but also involves achieving trust and respect, the imparting of cultural standards and traditions, and the patient and self-sacrificing work of colonial servants over a long period of years. That is the basis of collaboration and of constructive criticism. Mr. Jones's review of British colonial policy in the West Indies and of Anglo-American co-operation in the Caribbean leads him to welcome and foreshadow, first the gradual extension of responsibility for dependent areas from the single Power exercising administration to the international society represented by regional commissions; secondly, the bringing together of dependent peoples themselves in regions where a community of need or interests exists to help each other in the attack on common problems.

Already it is clear that only an organization on the lines of the Middle East Supply Centre offers any prospect of securing the regional co-operation which is essential for effective development in that area. Unilateral action tends to provoke political difficulties even when it possesses the resources to achieve its limited purpose. The *Fortune* article may therefore be welcomed as evidence of a responsible point of view in the United States, and that at least some support will be forthcoming for the use for post-war purposes of effective instruments shaped primarily to serve war-time ends. The oil conference which began in Washington on April 16 may also promote confidence. The seconding of Dr. B. A. Keen and Dr. E. B. Worthington as joint scientific advisers to the Middle East Supply Centre to undertake a survey of scientific problems of the Middle East, from Libya to Persia and from Syria to the Sudan, indicates the importance attached by the British Government to the Centre as well as to scientific work overseas. The appointments should at least rouse further interest among scientific workers in these regional developments, the potentialities of which are as yet not widely appreciated.

It should not be thought, however, that obstacles to such developments are to be found in the United

States alone. Lord Cranborne, it is true, in a statement in the House of Lords, has indicated that the British Government would welcome collaborative and consultative machinery to facilitate the solution of problems which transcend the boundaries of political units in appropriate areas. This statement, which may well be an indirect reply to General Smuts' explosive thoughts on the new world last November, to some extent discounts the reluctance of the Government to commit itself in statements regarding the future of the Middle East Supply Centre. Moreover, there is nothing in the *Fortune* article which is at issue with the principle firmly maintained by Lord Hailey in his lectures at Princeton University in February 1943, which have now been published under the title "The Future of the Colonial Peoples" (Oxford University Press. Issued under the auspices of the Royal Institute of International Affairs. 1943. 3*s*. 6*d*.), that administrative responsibility must be undivided. The willingness or eagerness of the Colonial Power exercising administrative responsibility to govern and develop its dependent territories in accordance with the outlook and spirit of the international community does not, and should not, mean divided administrative responsibility.

It is not only in the Caribbean and in the Middle East that British colonial policy during the War has earned the sympathy and co-operation of the United States. "Mass Education in African Society", issued by the Advisory Committee on Education in the Colonies early this year (see NATURE, May 20, p. 606), indicates an outlook which is an immeasurable advance on the views of even two or three decades ago. Recognizing that the most formidable obstacle to development in Africa is illiteracy, the report argues that the problem must be attacked by the means, and on the scale, adopted in the U.S.S.R., China and Turkey. The evils and injustices which have to be overcome in Africa demand leadership, co-operation and an informed and intelligent public spirit. Co-operation, the active participation of Africans in the administration of their own country and the execution of great schemes of social reform are impossible if the community remains illiterate.

Education and social welfare must go hand in hand; and as Turkey has combined mass education with the organization of rural industries, so we may use it to meet the need, which Lord Hailey has emphasized, for greater specialization in African rural economy. By the measures indicated in the report, including the wide extension of schooling for children, with the goal of universal school within a measurable time, the spread of literacy among adults, together with the development of literature and libraries, the planning of mass education within the community as a movement of the community itself, involving the active support of the local community from the start, and the effective co-ordination of welfare plans and mass education plans so that they form a comprehensive and balanced whole, the report believes that proposals could be advanced for eliminating illiteracy within the next two or three decades.

With the details of the task ahead so ably delineated in the annexure to this report we are not concerned here, but the spirit and outlook of the whole document should compel tribute from even the severest critics of British Colonial policy. The note of urgency is rightly struck, for the next stage of partnership with the Colonial peoples cannot follow that of trusteeship unless and until those peoples are given every opportunity of equipping themselves to take their full place in the modern world. Moreover, this may well demand as generous provision of finance as schemes already under consideration for welfare and development. If mass education and welfare plans are in fact to be comprehensive, balanced and co-ordinated, there must be full understanding on the part of the citizens of Great Britain; for the responsibility of finding the necessary financial assistance will fall on them.

The case so ably argued in this report deserves to be made known as widely as possible, and it is the more important that public opinion in Great Britain should awake to the opportunity. The French Committee of National Liberation is considering a number of recommendations on French Colonial problems coming from a conference held at Brazzaville. These proposals also would handle public health and education in a large and generous spirit. They call, for example, for mass treatment of malaria and more preventive measures. A central school for medicine with a well-organized mobile service would demand an addition of 700 French and 1,800 African medical men.

Nor is it only in such fields as these that friendly emulation should arouse a wider and deeper public interest in Great Britain in Colonial affairs. When we are seeking with Lord Hailey to transform our relationship to the dependencies from that of trusteeship to that of partnership, it must be recognized that there are parts of the Empire where, in spite of specific pledges, the term trusteeship can scarcely be used to describe the spirit of our policy. Of these Kenya is a striking example, and uneasiness, not to say dissatisfaction, has repeatedly been expressed in both Houses of Parliament on this question. It is not too much to say that in Kenya the disparity in the treatment of the rights of the settlers and the rights of the indigenous population has become a matter of grave concern. That is attested by the studies in Lord Hailey's "African Survey" and by Sir Alan Pim's report on the financial position of Kenya quite as fully as in the less dispassionate publication of the Fabian Society, "Kenya: White Man's Country?" (Research Series No. 78). The Colonial Office is studying plans for remedying this neglect, which it is understood would provide for expenditure under the Colonial Development and Welfare Act on such objects as housing for Africans and the improvement of hospital and school accommodation. The Fabian Society paper welcomes such measures, but urges improvement both in the labour legislation and administration of the Colony—matters on which the recent International Labour Conference may be expected to have some beneficial effect.

There is substantial support for the view that white settlement in Kenya should never have been encouraged; but the termination of existing white settlement is rightly dismissed by the Fabian Society

report as not practical politics. On the other hand, the maintenance or extension, by fresh settlement, of the present privileged position of the European settlers is firmly opposed, and a programme for the political and economic advance of the population of Kenya as a whole is advocated as the most reasonable policy. This will involve various development schemes, as well as attention to the whole question of industrialization and the provision of transport, political representation of Africans and the abolition of all discrimination in favour of non-Africans regarding land occupation and tenure, backed up by vigorous attention to soil conservation, agricultural improvement and the like.

This report to the Fabian Colonial Bureau is a reminder that it will not always be possible to avoid political issues in dealing with Colonial problems. Much can be done, however, to make the political difficulties less acute by appropriate action in technical fields. Therein lies, in fact, one of the greatest hopes of a real contribution from such regional experiments as the Middle East Supply Centre to the solution of particular and dangerous political problems. The recent conferences organized by the Middle East Supply Centre, particularly the Agricultural Conference in Cairo, have shown, for example, that Jews and Arabs can come together to discuss schemes of regional development. Joint plans for raising the standard of living of Jew and Arab alike might go far to eliminate distrust and friction, while war-time experiments in the production of chemicals, plastics and rubber from industrial crops may stimulate the growth of a new technical and professional class in each community, with interests in common. This should still further assist participation in regional development schemes and provide wider possibilities of economic and political co-operation.

What is required is that the opportunities which are opened up for statesmanship should be realized and grasped. In Palestine, for example, there are possibilities of dealing with the difficult racial problem on wider lines in association with a Syrian Federation and with regional economic development in the Middle East. The West Indies Conference which opened at Barbados on March 13, when for the first time representatives of the Caribbean possessions of Britain and the United States met to discuss their common problems and work out a co-operative programme of action, has similarly indicated possibilities of Anglo-American co-operation which, if used with imagination and wisdom, may profoundly influence future world organization. Again, the present position affords us a great opportunity of putting Kenya on a sounder basis, both by large social reform and also by increasing African representation on governing and administrative bodies. There is much to be said for sending to East Africa a commission to do there what the Stockdale Commission did in the West Indies.

Whether or not such a measure be adopted, a report issued for consideration at the International Labour Conference entitled "Minimum Standards of Social Policy in Dependent Territories" will assuredly enforce reconsideration of British policy and administration in Kenya and elsewhere. No one document has put better than this report in its opening chapter the implications and possibilities of recent regional developments, and shown how successive steps such as the establishment of the Anglo-American Caribbean Commission, the Middle East Supply Centre and more recently the Agreement of January 21, 1944, between the Governments of Australia and New Zealand, envisaging the establishment of a South Seas Regional Commission, make one pattern.

The chief strands in this pattern are becoming clearer. They include a heightened conception of responsibility and an increased tempo in the development of self-government, closer relations between the dependencies and other interests in the different regions, and growing recognition that a main aim of policy should be the establishment of freedom from want; increasing co-ordination of economic and social programmes; a wider conception of social policy to include educational, public health and labour reforms; the establishment of new tropical industries and diversification of tropical agricultural production. The remoteness of tropical regions may well largely disappear through the development of air transport, but it is clear already that, apart from the world interest in security and welfare, these matters affect more than the Colonial Powers directly responsible for the administration of the separate territories.

It seems that, making allowances for local exceptions, the general economic foundations of social progress in dependent territories will be the development of the existing primary industries, supplemented by secondary industries concerned largely with processing primary products and providing elementary needs. Peasant development involves special difficulties, such as land tenure, where the spirit in which policy is administered is important. Again, there is the disputed question of compulsion for educational purposes or in the general interest of the country, and thirdly, the general problem of increasing the welfare of the peasant cultivator, not only by improving his methods but also by organizing the supplementary economic activities which he is not able to provide for himself.

Once again in this report we find the importance of education is stressed, particularly with reference to the evolution of self-reliance in social policy, the development of an individual and communal sense of informed responsibility, and of effective organs of consultation and collaboration. For the latter purpose the establishment of boards to deal with the co-ordination of social policy is suggested, and as a feature of regional technical collaboration the use of regional labour conferences. The main proposal of the report is that the appropriate authorities should examine the advisability of accepting certain fundamental principles of social policy in dependent territories and of providing for the extension and development of international minimum standards to such territories. A draft of such standards is included for submission by international agreement to the authorities concerned with a view to their application to dependent territories. These standards might also

serve as the principles subject to which the financing of developments in under-developed territories might operate.

In the territories where the present Colonial Powers retain direct control over labour and social policy, the fundamental principles formulated in this report should serve without difficulty as a basis of policy. If they are to apply to territories with wide and growing powers of self-government, the association of the immediate governments of those territories and their organized employers and workers will be required. Every effort must indeed be made to obtain the effective collaboration of peoples now dependent, in the amplification and execution of all measures on which their progress and well-being depend. That is a main purpose of the mass education programme, as it is part of the technique for executing that programme. Besides this, a large amount of technical and indeed scientific collaboration will be involved, and it behoves all whose services may be required in such duties to do their utmost to take the problems of development into an atmosphere of dispassionate inquiry and disinterested service. In so doing they best promote the participation of the American people with us and other trustees of Colonial peoples in the patient but expensive work of establishing the adequate basis in economics and education which is essential before politically immature peoples can stand alone. The cool critical spirit of scientific inquiry is an indispensable factor in the collaboration by which alone we can realize the immense possibilities inherent in regional developments, and build a new Colonial order in which freedom from want and from fear are assured to all without distinction of race.

VESALIANA

A Bio-Bibliography of Andreas Vesalius

By Harvey Cushing. (Publication No. 6, Historical Library, Yale University Library.) Pp. xxxviii+230 +86 plates. (New York: Schuman's, 1943.) 15 dollars.

ONE of the most remarkable developments of exact learning in recent years is the growth of an interest in the history of medicine and science which has shot up in the United States of America. It started almost from nothing, and with bibliographical resources wholly inadequate for detailed and accurate studies. The two Americans who stand out before all others in this movement are William Osler and Harvey Cushing—the former, it is true, of Canadian birth, but none the less an adopted and loyal son of the United States. Both must have been born with the love of books in the blood, and, having achieved eminent success in an opulent profession, they were able to impart a new and sustained impetus to the steady flow from Europe to America of the rarest and most expensive books in medicine and science.

Both Osler and Cushing were gifted with an impelling and charming personality, and succeeded almost without effort in communicating to others their own enthusiasm for the old masters. Like Prince Florizel of Bohemia, they gained the affection of all by the seduction of their manner and by a well-considered generosity. When Osler found himself in possession of six exemplars of the first edition of the "Fabrica", besides those already in his library, he offered copies to two institutions which as it happened possessed much better ones *presented by himself*! To those who knew Cushing only in his mature years, it comes as a shock to learn of a time when there were "cobwebs in the purse", and when a new purchase had to be smuggled into the house by the back door. But in later years he never considered the cost when there was a prospect of closing a vital gap in the library, and if sometimes he was inveigled into paying £50 for a book which should have cost him 50*s*., he at all events got what he wanted. He was, however, by no means the only American intent on acquiring the classics of medicine and science. There were many other costly private libraries in the making, and, as they grew, so the work of American historical scholars reached a degree of excellence which it would be presumptuous to praise. In one respect, however, these activities are by no means grateful to their European brethren, since America is clearly answerable for the astronomical prices which booksellers are now demanding, and presumably getting, for the older literature. For example, in my younger days I paid 50*s*. for an excellent copy of the first folio edition of the Parisian Memoires, but to-day the same bookseller is asking £75 for it, and the first edition of Harvey on the circulation has progressed from 4*s*. 6*d*. to £800!

The methods adopted by Osler and Cushing in building up their famous libraries were similar and effective. The books were personally hunted down in the collections and bookshops of Europe, the booksellers of which quickly discovered what America needed and made it their business to supply it. As Osler remarked on one of these forays: "I have bagged two 1543 Fabricas. 'Tis not a work to be left on the shelves of a bookseller. . . . We cannot have too many copies in America." The Surgeon-General's Library at Washington is the most complete and best catalogued collection of books of its kind in the world, and if we add to it the numerous private and public scientific libraries, it will be evident that the American student of the history of medicine and science is, from a bibliographical point of view, in an exceedingly strong position. For example, the stately new library of Yale University now houses collections of the earlier literature of the highest importance and value.

As we learn from Prof. Fulton, Cushing spent the last year of his life in preparing the present work for the press. For more than forty years he had been interested in Vesalius, and for the last twenty he had been collecting material for his book, the writing of which was still claiming his unremitting attention until within a few days of his death. The introduction and first five chapters had been completed, two others were planned, but the last three were untouched. "Had he lived a few months longer, he would, no doubt, have finished the work to his own satisfaction." These finishing touches, however, have been faithfully supplied by Prof. J. F. Fulton, Dr. W. W. Francis and Dr. A. Castiglioni. In the completed work the introductory matter includes Cushing's delightful personal "Apologia", a short sketch of the time and circumstances which led to the composition of Vesalius's works, the relations between Vesalius and his illustrator Calcar, and Cardan's horoscope of Vesalius. Chapter 1 deals with

Vesalius's degree thesis—"The Paraphrase of the Ninth Book of Rhazes"; Chapter 2 with the "Tabulæ Sex"; Chapter 3 with Vesalius's edition of Guenther's "Institutiones Anatomicæ"; Chapter 4 with the venesection epistle; Chapter 5 with Vesalius's contribution to the "Opera Galeni"; Chapter 6 with the "Fabrica" and its sequelæ; Chapter 7 with the China-root epistle and the aftermath of the "Fabrica"; Chapter 8 with Vesalius as a consulting physician; and Chapter 9 with the Fallopius-Vesalius controversy. Chapter 10 is a valuable bibliography of Vesaliana, which is followed by an index of recorded copies, a chronology of editions, and an index of names.

Cushing's conception of what a bibliography should be was emphatically the right one. To him a book like the "Fabrica" of Vesalius was a living influence, and to dismiss it in arid records of dates and collations did violence to his artistic sense and penetrating imagination. Consequently he discusses the details and circumstances of its printing and illustration, the methods of publication and the wiles of publishers, the unblushing operations of the plagiarists, and above all the environment in which the book was conceived, and its influence on contemporary and posterior thought. He even tells us how, when, and at what cost he acquired his own copies. All this results in the production, not of a reference book which is promptly relegated to the shelves, but of a scholarly human treatise which can be read.

The most valuable sections of the work are the chapters on the few and rare fugitive sheets known as the "Tabulæ Sex", on the "Fabrica", and on the more popular "Epitome". It is doubtful whether any private or public library rivals Cushing's collection of Vesaliana, and he could hence pursue his studies at home with but occasional extraneous intervals. The bibliographical details which are given will be indispensable to students of Vesalius and librarians generally, not to mention the specialist booksellers. Cushing bequeathed his books to his old University, and Prof. Fulton has now added his own collection, so that Yale can offer almost unique facilities to those who wish to undertake historical researches in America. In this connexion two observations and an anecdote which are related by Cushing in this work may be recalled. History, he remarks, "has proved a solace for many of us in our later years"; and again, "the Fabrica has probably been more admired and less read than any publication of equal significance in the history of science". Now the anecdote: in 1914 Cushing and Streeter decided to celebrate the quatercentenary of the birth of Vesalius by an exhibit at the spring meeting of the American Medical Association. "For this purpose," he says, "we were allotted a booth and had a small pamphlet printed with a description of the books we had selected for display. It aroused little if any interest. We had arranged to alternate as showmen, Streeter in the morning hours, I in the afternoon. We met at lunch after the first morning and on my enquiring 'How did it go?' he replied, 'Well, only one old codger stopped long enough to read the sign VESALIAN EXHIBIT and said, 'Got any samples?' Streeter asked 'Samples of what?' He pointed to the sign and said, 'Samples of 'Vaseline', of course'. Sadder and wiser we returned to Boston with our 'samples' at the end of the week."

It only remains to add that this memorial to a great European is also a memorial to a distinguished and beloved American. It has been beautifully produced by the publisher, Henry Schuman.

F. J. COLE.

AMERICA A CENTURY AGO

Mirror for Americans

Likeness of the Eastern Seaboard, 1810. By Prof. Ralph H. Brown. (American Geographical Society Special Publication No. 27.) Pp. xxxii+312. (New York: American Geographical Society, 1943.)

THIS work is, in its author's words, "intended as a short cut to an understanding of American geography in 1810". It is compiled from a great variety of sources and is written in the style of the period it portrays. Its author is to be warmly congratulated on his skill and his imagination: the former has produced an admirable account of the historical geography of the eastern seaboard in or about the year 1810; the latter has invented a character, Thomas Pownall Keystone, who tells the story "which he might have written and illustrated" through the medium of Prof. Ralph H. Brown.

The work covers every field of activity and enables us to see, in their early stages, some of the fundamental questions that have been presented to the Republic. Was the climate changing and had it changed? Some, relying on earlier accounts of the country, said it had. Others, from scientific examination, argued that increasing cultivation led to less severe winters but "more inconstant, variable, and unsteady weather". One scientific worker maintained there had been no change. In a note Prof. Brown remarks: "the question of climatic change . . . pervades the entire literature of this period".

What population could this new country support? Some took the gloomy view, and put the limit at ten millions. Others optimistically predicted a population of eighty millions in 1876—a figure of thirty millions more than was attained. One writer foretold a population of 860 millions in 1946! These speculations were natural in view of the rapid growth of population at the beginning of the last century, largely through a great excess of births over deaths. But already the problems of this population were showing themselves. The Negroes were increasing both relatively and through the continued import of slaves and had already become a 'problem' in Virginia, where in parts there were "more blacks and even more slaves than free white persons". One Virginian contrasted this evil "which is now so thoroughly incorporated" with the happy state of New England, where the problem scarcely existed.

Much of this book is taken up with detailed accounts of means of communication, occupations, trade and industry and with regional accounts of various parts of the seaboard. Each chapter has its particular interest, too detailed for quotation in a short notice; such as coastal erosion at Cape Cod; the beginnings of the textile industry in the northern States; the spread of settlement westward in New York State; the commercial interest in Florida, then "little better than a wilderness" and still a Spanish possession; the industrial future of Pennsylvania, delayed only by "the difficulties of transportation and the prejudices of the people"; and the planning of the lay-out of some of the cities of the east. Dominating all is the story of the subjugation of a country by human enterprise shown in a great variety of ways. The continent was one of possibility: the population of the eastern seaboard was exploring and exploiting the immediate possibilities and, when tempted by land speculators or roused by curiosity, or even impelled by its growing numbers, was pressing westward to sample the wealth of an almost unknown

interior. This last region was, however, largely a blank on the maps in the mythical library of "Thomas P. Keystone, Esq." and is not discussed in this book.

This fascinating story is illustrated by a number of contemporary maps, plans and views, and Prof. Brown has added a select bibliography and many useful notes. The book is issued by the American Geographical Society and more than maintains the high standard of its publications.

J. N. L. BAKER.

PRACTICAL PHYSICAL CHEMISTRY

Physico-Chemical Methods

By Prof. Joseph Reilly and Prof. William Norman Rae. Fourth edition, revised. Vol. 1. Pp. ix+610. Vol. 2. Pp. vii+586. (London: Methuen and Co., Ltd., 1943.) 2 vols., 84*s*. net.

THE fact that another edition of "Reilly and Rae" has been called for after a lapse of only three years —abnormal years from the academic point of view—is adequate testimony to the usefulness of this comprehensive work on practical physical chemistry. A complete revision would have been impossible, but the authors have managed to prune out a good deal of material more suited to an introductory text than to an advanced treatise. Simultaneously they have introduced new matter by adding the necessary pages under a decimal system of pagination; the original pagination thereby being preserved. It is to be hoped that this war-time measure will disappear when conditions permit. The whole work tends to grow, for another volume is promised, dealing particularly with gas analysis, microanalysis and related topics.

Space prevents mention of all the additional matter, but the authors have lost no opportunity of introducing methods of recent origin; for example, in volume 1 Emmett's method for the determination of the specific surface of sub-microscopic particles, high-speed stirring equipment, data on the properties of laboratory glasses, the latest apparatus for hydrogenation and new photographic techniques and sensitive materials. Previous gaps have been filled by the inclusion of new sections on the graphical representation of three-component systems, thermocouples and thermopiles, and on the determination of the specific heats of liquids. Similarly, in volume 2 there are innumerable additions. Gas analysis is an ever-expanding technique, while distillation naturally assumes an important place with appropriate additions to an already complete chapter. There is an especially interesting and valuable section on microdiffusion in liquid systems. Brief mention is made of the technique of growing large crystals and of some of the applications. A few pages are devoted to the air-driven ultracentrifuge, but the oil-driven type is only mentioned in passing. Although some small additions are made to the chapter on adsorption, the necessary expanded treatment is reserved for the third volume. A similar arrangement is made for the electron microscope. The glass electrode and the measurement of the dielectric properties of solids both come in for some revision. There is only a small point of criticism. A few of the diagrams could be better drawn in order to be worthy of the work as a whole.

In a comprehensive book of this character, it is presumed that every topic having a bearing on physical chemistry must be described. To follow such a presumption leads to difficulties, for in some directions the techniques have become so highly specialized as to be unsuitable for inclusion in this kind of manual. They require to be treated by a specialist in a separate monograph; for example, the ultracentrifuge, electron microscope, infra-red spectroscopy, X-ray crystal analysis and radioactive technique come into this category. While the omission of these topics might leave the impression of incompleteness, no physical chemist would reasonably object, since standard works on these subjects exist. The real function of the volumes under review is to bring together all the multiplicity of techniques, methods and appliances used in modern physical chemistry, but often unknown to, or undiscovered by, those practising the subject. "Reilly and Rae" already fulfils this function, and it is hoped will continue to do so in an even greater measure with the promised appearance of a third volume to complete the work.

H. W. MELVILLE.

THE EXTRUSION OF METALS

The Extrusion of Metals

By Claude E. Pearson. Pp. viii+205+37 plates. (London: Chapman and Hall, Ltd., 1944.) 18*s*. net.

IT is not a little surprising that an important industrial process, well over a hundred years old, should have had to wait until now for an author. Particularly is this the case where the process is one which has shown such marked advances as has extrusion during the past twenty or thirty years. Starting as a means of forming lead pipes, it is now a method of working metals which is of first-rate importance, and its potentialities, so far from being exhausted, may result in its serious incursion in the comparatively near future from the realm of nonferrous metallurgy into that of the steels.

In this little volume the author gives a general survey of the whole field, theoretical as well as practical. The treatment is well balanced, and the information, collected from many sources, is clearly and impartially discussed. It is, however, more or less of an introduction to the study of extrusion, and to those already familiar with the process and the materials to which it is applicable, there will not be much which is unknown.

How much now remains to be investigated is shown by the wide gaps which still exist in our knowledge of the nature of the flow of the metal and the stresses required to effect it. The shape and contour of the die, for example, a matter to which the wire-drawer has for long devoted most careful consideration, receives only the most general treatment, although it must have a profound influence upon the ease with which the process is carried out. In this connexion, too, it may be pointed out that equation (8) on p. 125, in which the die angle is introduced, is similar to one proposed for wire-drawing, where its predictions are by no means entirely in accord with experimental results.

As a general introduction to its subject, this book is good; in its implications of the large field of work still demanding attention, it will be of real service to the research worker, but one puts it down with the impression that a process of such immediate importance and with such immense possibilities of expansion deserves a more comprehensive and detailed treatment than it has yet received.

F. C. THOMPSON.

Elementary Morphology and Physiology for Medical Students

A Guide for the First Year and a Stepping-stone to the Second. By Dr. J. H. Woodger. Third edition. Pp. xvi+522. (London: Oxford University Press, 1943.) 15*s*. net.

FIRST published in 1924 this text-book has now passed into its third edition, a fact which testifies to its usefulness. The book has been thoroughly revised and an additional chapter on insects, with *Periplaneta americana* chosen as the type, has been included. The revision has been well carried out on the whole, and this has involved some of the illustrations as well as the text, but it is a pity that the account of mitosis was not more completely rewritten and not simply left as the traditional account with a note that it requires modification in the light of recent observations.

The book differs from many of the text-books for medical students in that it assumes the use of other practical texts for the acquisition of factual knowledge; the author rightly observes that no book can replace personal observation. This does not imply that the treatment of morphological facts is omitted; they are indeed well treated, but the emphasis laid upon them is not so marked, and more attention is paid to what, for the want of a better term, may be called theoretical aspects. In order to do this satisfactorily the author has found it necessary to go outside the actual types laid down in the examination syllabus; for example, the interesting chapter on the primitive Amphibia and the reptiles, to give an idea of the history of the origin of the mammals. The result is that the reader will obtain a rather wider outlook on matters zoological. Perhaps one of the most important sections from this point of view is the chapter on theoretical biology and the methods of science, and the student would be well advised to read this carefully and consider its applications to all his work. The text and illustrations are well done, and the volume is deserving of commendation.

Ultra-fine Structure of Coals and Coke

Proceedings of a Conference held at the Royal Institution, London, June 24th and 25th, 1943, by the British Coal Utilisation Research Association. Pp. 366. (London: H. K. Lewis and Co., Ltd., 1944.) 25*s*. net.

A CONFERENCE on the structure of coal was held in London on June 24–25, 1943, and the present volume is an account of its proceedings. It comprises a set of scientific papers together with discussions of their contents and forms a valuable book of reference for those who study coals and cokes.

It can scarcely, however, be regarded as a book of reference for facts, since the general impression given is of the lack of knowledge about the subject. This is evidenced by the number of theories put forward by the various investigators and by the, at times, rather impatient tone of the discussion. While this state of mind is probably inevitable at the beginning of a new subject—as the scientific study of coal undoubtedly is—one feels that more receptive states of mind would be a happier augury for the future.

On the other hand, the promoters of research are to be congratulated on their breadth of vision in applying new research tools. These include X-ray diffraction, electron microscopy, the measurement of the heat evolved in wetting by certain organic liquids, the measurement of magnetic anisotropy and infra-red spectroscopy. While none of the methods employed has given a complete answer to any of the problems raised, the integration of the results they are producing is bound to be informative. If, therefore, the present volume is regarded as a 'clearing house' for ideas it will have served its purpose. It would be interesting to see what a corresponding volume would contain if it were produced in, say, twenty years time. H. L.

The Biotic Provinces of North America

By Lee R. Dice. Pp. viii+78. (Ann Arbor, Mich.: University of Michigan Press, 1943.) 1·75 dollars.

BY recognizing a series of floras associated with definite areas in North America in 1830, C. Pickering laid the foundation of the biogeography of that area. This was added to in 1843 by R. B. Hinds but established on more or less modern lines in 1859 by J. G. Cooper, who recognized a series of regions to which geographical names were applied. Since that time a great deal of attention has been paid to this topic both in the broad sense of dividing North America as a whole and in the more detailed analysis of limited areas from the points of view of the distribution of plants or animals or the effects of climate.

Lee R. Dice has made the most recent contribution to this subject in the book under review, in which twenty-nine biotic provinces are recognized and a map showing them is provided. By biotic province the author means a continuous area of reasonable size that is characterized by one or more ecological associations that differ sufficiently from those of adjacent provinces to constitute an entity. In the absence of some striking geographical barrier it is obvious that one province may pass over into the next and so the position of the actual dividing line may be a matter of convenience or opinion. In view of their different natures, plants can be utilized more readily for such a purpose than the more mobile or even migratory animals. The author, whose contributions to the zoogeography of vertebrates are well known, has considered fully the previous work and so far as possible utilized in his terminology names that have been applied already, with the necessary redefinitions. It would be unfair to leave the impression that the book is merely a résumé of the work of others. He has himself studied the ecological associations and conditions in nearly all the provinces, and it is in his critical evaluation of these factors that the main value of this well-produced volume lies.

The American Land

Its History and its Uses. By William R. Van Dersal. Pp. xvi+215+65 plates. (London, New York and Toronto: Oxford University Press, 1943.) 21*s*. 6*d*. net.

IF a book can be classed as good when it fulfils a predefined object, then this book is good. The author has been fully impressed by the wealth and greatness of his own country, and in simple but logical diction has painted a canvas of distinction. Corn, wheat, barley, fruit, cotton, vegetables and subsidiaries are all there in detail, which is surprising, considering the simple terms used; and a series of excellent photographs makes for a well-balanced whole. As learning increases, so man's ability to absorb the whole of it decreases. The consequent era of specialization has created gaps in human knowledge which appear impossible of closure, and in a sense these gaps may be accounted a serious detriment. The real value of this book is as a stepping-stone across the break. D. CARPENTER.

HUMAN LIMITS IN FLIGHT*

By DR. BRYAN H. C. MATTHEWS, F.R.S.
R.A.F. Physiological Laboratory

A MODERN aircraft will climb in a few minutes to heights at which the air is so thin that it will no longer support life. It can turn and manœuvre so fast that the pilot may easily be rendered unconscious from the mechanical forces which it can impose on his body, and in an aircraft which is moving rapidly in three planes of space the pilot can be subjected to stresses beyond the limits which the human body can stand.

The adaptation of which the human body is capable to new surroundings and conditions can play a considerable part in fitting man to these new conditions; for example, airsickness which many suffer on first flying in rough air or doing aerobatics, in most people soon passes off and they become adapted to motions which at first perplex and incapacitate them; though a few never become completely adapted. But there are several stresses placed on man in aircraft that cannot be met by any unconscious adaptation, which require equipment specially designed to meet them. Some of the necessities are obvious, such as windscreens to protect the man from the enormous wind pressures at high speed and a heat supply from the engine and special clothing to keep him warm in the arctic cold of the stratosphere. His senses must be extended by a set of blind-flying instruments so that he may know his altitude and movement in space when in clouds or at night. He must learn to believe the instruments against his senses, for these are no longer a reliable guide when he may be moving at varying speeds in any direction—in fact, they will often be wrong. The human limit of visual range by day and especially by night is of paramount importance in flying.

But besides the stresses from wind pressure, cold, vibration and noise, the pilot's body must also be protected from other less obvious stresses, and here I propose dealing particularly with the two greatest stresses which an aircraft puts upon the pilot: those due to acceleration or rapid change of motion and those due to high flying in the rarefied air of the upper atmosphere.

In the last hundred years man has increased the speed at which he can travel more than tenfold, but there is no reason to suppose he is approaching any human limit in speed for, provided that he is protected from wind pressure by a closed cockpit and that the motion does not change rapidly in direction, there is no more mechanical stress on the pilot than if he were sitting on the ground.

If the human body is moving uniformly there is no force acting on it other than that due to gravity, recognized as weight. But when the motion changes in either magnitude or direction, large forces come into play; for example, while launching an aeroplane by catapult. During this linear acceleration, the pilot has the sensation of being driven backwards against his seat by forces equalling several times his own weight. This is seen in the retracting of the skin of his face, which bares the teeth like a snarling dog. In this case, the acceleration acts transversely on the body and lasts only a few seconds, and in this direction the pilot can easily withstand many times the acceleration of gravity provided his head and shoulders are well supported.

When a fast-moving aeroplane changes its direction and turns, aeroplane and pilot are both subjected to very large forces. The phenomenon known as blacking-out came into prominence in the Schneider Trophy races; pilots found that in turning at high speed their vision became blurred and that for a few seconds in the turn they frequently became blind. This is now a common event in aircraft and is well understood by fighter pilots.

When an aeroplane travels in a curved path in turning or pulling out of a dive, a large centrifugal force tends to force the aeroplane and pilot away from the centre of the circle. The magnitude of this force increases with the square of the speed and decreases as the radius increases. Subjectively, a pilot experiences a great increase in weight of all parts of his body as the centrifugal force tries to drive his body out through the bottom of the aeroplane. The magnitude of the acceleration acting on the pilot is expressed in terms of g, the force due to gravity normally acting on the body which causes it to have its normal weight. Thus in a turn producing $4g$ or four times the force of gravity, if the pilot's seat were fixed to a spring balance it would register four times his normal weight and the pilot and all parts of his body become extremely heavy. This is seen in the sagging of the soft part of the face which occurs in a tight turn (Figs. 1a and b). A turn at 300 miles per hour and 1,000 feet radius produces $6g$, and a pilot in effect weighs about half a ton and his blood virtually becomes as heavy as molten iron. The blood is normally being pumped to the pilot's head by his heart, but as its virtual weight increases, the heart has difficulty in maintaining the blood supply to the head. The brain and the eyes can only function for a few seconds without their normal blood supply, and loss of vision in blacking-out is due to failure of the circulation in the retina of the eye. If the acceleration is still greater, the whole blood supply of the brain fails and the pilot becomes unconscious.

Blacking-out is a warning that the blood pressure in the cerebral arteries is getting low. If the control column is eased forward, the aeroplane straightens out, the centrifugal force ceases and within a few seconds the circulation returns to normal. While this happens in the head the deficit of blood tends to gravitate to the legs, and the phenomenon can be regarded as the head losing blood to the feet.

This draining of the blood from the head takes time. The greater the acceleration the less the time that the pilot can retain his sight.

Many measures have been taken to reduce the effect of centrifugal force on the pilot; much may be done by posture and seating. If the pilot's attitude is crouched with his legs raised, the distance through which the heart has to raise the blood to his head can be reduced, and the loss of it to his feet is again less if the feet are high. Another method of lessening the effect of this force which may be mentioned is to place the pilot in the prone position. The heart and head are then nearly at the same height and a man in this position can withstand some $10g$, but this posture is a very fatiguing and inconvenient one for the control of an aircraft, though it is reminiscent of the very earliest aeroplanes in which the pilot frequently lay prone. The effect of posture on blacking-out is shown diagrammatically in Fig. 2.

The engineer has produced machines that are so strong and manœuvrable that they can subject the

* Friday evening discourse at the Royal Institution, delivered on June 11, 1943.

pilot to forces beyond his tolerance, and the useful limit in design for manœuvrability at high speed changes from being an engineering limit to being a human limit. It would be useless for the aircraft designer to produce an aeroplane so strong and manœuvrable that it could turn with a centrifugal acceleration of $20g$, because the pilot would not be conscious to control it under these conditions; the ability to out-turn the enemy has an important tactical advantage in 'dog-fighting', but to achieve this it is now necessary to look to the man rather than the machine. Fig. 3 illustrates how the human limit makes it impossible for a fast aeroplane to follow a slow one in a tight turn; both pilots are subjected to $5g$.

The most important stress, however, to which man is subjected in aircraft is that resulting from the thinness of the air at great altitudes.

The air pressure at ground-level is 14·7 lb./sq. in. (Fig. 4), it has fallen to one half at 18,000 ft. and to less than one fifth, about $2\frac{5}{8}$ lb./sq. in., at 40,000 ft. The effects of altitude on man are those resulting from the lowered atmospheric pressure.

The disabilities which a man suffers at lowered pressure first came into prominence on the surface of the earth as 'mountain sickness'. Later the term 'balloon sickness' was given to the troubles experienced in high balloon ascents at the beginning of the last century; long before aeroplanes had become practical flying machines, the problems of high altitudes had been encountered, because early balloon ascents carried the balloonists to heights at which the air would scarcely support life, and at that time their knowledge of how to overcome this was lacking.

It is necessary to emphasize the difference between rapid ascent from ground-level, as in an aeroplane, and slow ascent in climbing mountains. In the latter case, weeks are spent at 15–18,000 ft. to become acclimatized to the thin air. Great changes occur throughout the climber's bodily processes which enable him to live at altitudes which are fatal to a 'sea-level' man. Acclimatization is soon lost on return to ground-level, so it is not possible to make much use of this in flying.

Climbers have reached 28,000 ft. on Mount Everest, but in contrast to this the first serious high-altitude accident occurred in 1875 when Tissandier with two companions went up in the hydrogen balloon *Zenith*. The balloon ascended to about 26,000 ft. and the occupants became unconscious; although they carried bags of oxygen they failed to make use of them. They became conscious again when the balloon descended to 20,000 ft. but then threw out ballast and the balloon rapidly ascended to about 28,000 ft. All became unconscious, and when Tissandier regained consciousness the balloon was at about 19,000 ft., descending rapidly, but his two companions were dead. This accident focused a great deal of attention on the physiological problems of altitude, and to investigate these Paul Bert constructed a steel chamber from which the air could be removed by a pump to simulate altitude conditions at ground-level. Since then a great deal of research has been carried out in such decompression chambers, on mountains, and in aircraft, on the nature of altitude sickness and the ways of overcoming it.

Fig. 1*a*. Man during straight and level flight.

Fig. 1*b*. In a tight turn producing acceleration of $4\frac{1}{2}g$ 15 seconds later.

The R.A.F. Medical Service uses decompression chambers in which a man can be taken to a pressure equal to that at 30,000 ft. in less than a minute, and are capable of producing pressures down to a small fraction of a pound to the square inch.

For life, man needs food, water and air. He can live without food for weeks, without water for days,

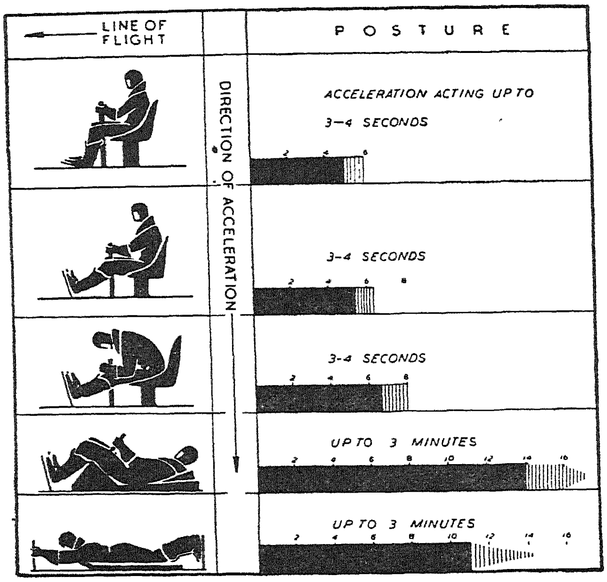

Fig. 2. EFFECT OF POSTURE ON THE TOLERANCE OF ACCELERATION. (DATA FROM RUFF.)

but without air he can survive only a few minutes.

At increasing altitudes, although the proportion of oxygen in the air remains one fifth, the density of the mixture becomes less, and a certain pressure of oxygen is essential for living cells to function normally. At an altitude of 42,000 ft., if the lungs are filled with air they contain less than one sixth of the normal quantity of oxygen, and this is insufficient to support life. Much of the Battle of Britain was carried out in an atmosphere in which a pilot unassisted with breathing apparatus would be dead in a few minutes. However, long before this height is reached, oxygen-lack makes its presence felt in the impaired intelligence and mental performance of the pilot. As oxygen-want comes on, judgment is lost, gross errors are made, intelligence fails, muscular control is lost and this may be followed by unconsciousness and death if the anoxia is severe. Moreover, oxygen-want is very insidious because the sufferer is often almost unaware of it. At 20,000 ft. a man without oxygen may do irrational things; oxygen-want resembles drunkenness both in its symptoms and in that the sufferer is confident that he is normal and much resents any suggestion to the contrary.

It would clearly be dangerous to send an aircraft up to 25,000 ft. unless it was ensured that the crew were protected from oxygen-want. Much research on the practical protection of flying personnel from the effects of altitude has been carried out by the R.A.F., particularly by the Medical Branch, which directs research in this very important side of the pilot's welfare. The importance of this is emphasized by the following true story of an incident which occurred over Germany. A pilot's breathing apparatus became disconnected, and the pilot thereupon told the crew that he was going to land. He put down his wheels and tried to land on a cloudbank at about 18,000 ft. He then told the crew over his intercommunication system that they were below ground-level and he was going to get out, whereupon the navigator, realizing what had happened, was in time to stop him climbing out of the machine, take over the controls and re-connect the pilot's breathing apparatus. It is easy to see that such an incident might not always have a happy ending. The effects of oxygen-want may often be extremely amusing, but clearly there is no place for such events in the dangerous and difficult work of high-altitude flying.

There are two ways in which altitude effects can be overcome. The first is to increase the amount of oxygen in the air which the pilot breathes by mixing oxygen from gas cylinders with it, thus giving the pilot a mixture rich in oxygen or even pure oxygen to breathe. In this way when the pressure is one quarter of an atmosphere at 33,000 ft., if his lungs are filled with pure oxygen he will not suffer from any symptoms of oxygen-lack. To this end the pilot always wears an oxygen mask, which also carries a microphone for his communication with the crew or ground.

The second alternative is to increase the amount of oxygen in the pilot's lungs by compressing the air in them. In an engine the loss of power from oxygen-lack is overcome by compressing the thin air with a supercharger; but it is not possible to supercharge the lungs so easily, as the pressures required would burst them. The pilot must therefore be completely surrounded by air at increased pressure. This can be done either with a pressure-suit something like a diving dress, or by sealing the cabin and making it strong enough to withstand a raised air pressure produced by a pump attached to the engine. The air around the pilot can then be kept at 14 lb./sq. in. and the atmosphere he breathes can be exactly like that at ground-level. However, it is clear that for military use such a pressure-cabin is very vulnerable, though for civil use it is the ideal method in high flying because the passenger is not inconvenienced by a mask on his face and need not be aware, by any change in the air pressure, that he has left the ground. Both alternatives are in use in civil airlines. The pressure-cabin has other advantages over the oxygen mask besides preventing lack of oxygen. At heights up to 36,000 ft. a man can avoid oxygen-lack by breathing pure oxygen, but above 44,000 ft., even breathing pure oxygen, he would become unconscious. Moreover, the vapour pressure of blood equals the atmospheric pressure at 63,000 ft., so if a man could reach this pressure his blood would boil and his lungs be filled with steam. At heights above 40,000 ft. it becomes necessary not only to breathe pure oxygen but also to increase the

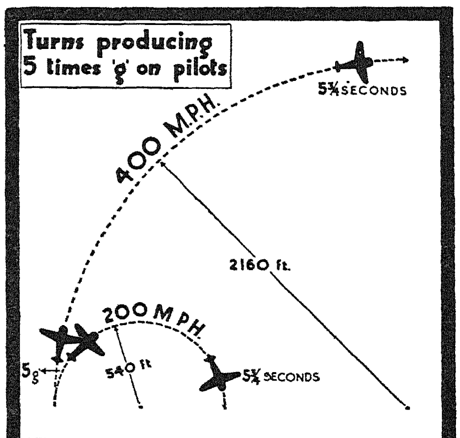

Fig. 3. HOW HUMAN TOLERANCE OF ACCELERATION MAKES IT IMPOSSIBLE FOR A FAST AEROPLANE TO FOLLOW A SLOW ONE IN A TIGHT TURN.

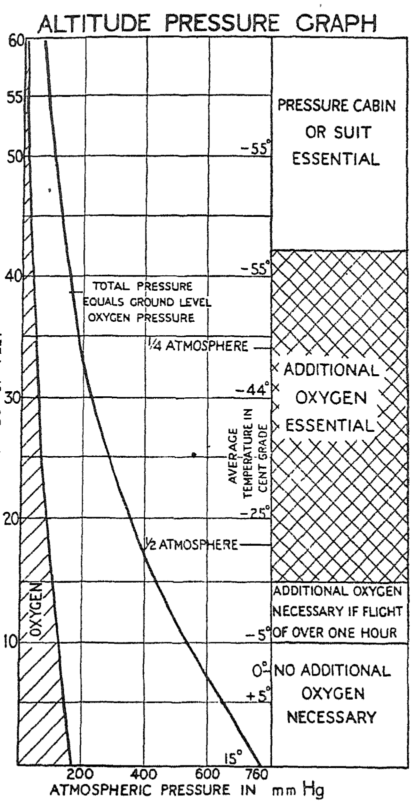

Fig. 4. Relationship between altitude and atmospheric pressure (I.C.A.N. scale).

pressure acting on man. When Flight-Lieut. Adam broke the world's altitude record by reaching 54,000 ft. in 1937, he wore a pressure-suit which was blown up to some $2\frac{1}{2}$ lb./sq. in. pressure and filled with pure oxygen. In it man could survive even in a vacuum. Thus the effects of oxygen-want can be completely overcome up to altitudes of some eight miles by breathing pure oxygen, and this is done in military aircraft of all nations. Above this height, pressure must be applied in addition. In the altitude record balloon ascents by Prof. Piccard and by the U.S. Army, closed gondolas at raised pressure were used.

Fig. 5 illustrates the time elapsing between cutting off the oxygen supply to a man and his becoming unconscious at various heights. From this it will be realized how quickly a pilot must act should his oxygen supply fail at high altitudes.

The physiological abnormalities at altitude are not entirely solved by breathing oxygen, as there are effects on the body at low pressure in addition to oxygen-lack. At ground-level the air pressure drives nitrogen into the blood which dissolves in appreciable quantity. If now the pressure on the man is rapidly reduced before this nitrogen can escape, it will form bubbles in his blood vessels and stop the circulation.

The possibility that bubbles might occur in animals at low pressures was envisaged in 1670 by Robert Boyle, who placed a viper under a bell-jar and pumped out the air; when the pressure was reduced he saw a bubble within the eye of the viper. Bubbles forming in the body fluids have long been a difficulty in deep diving where men have been subjected to much increased pressures of air. The body fluids then dissolve a large quantity of nitrogen, and if the diver comes to the surface too rapidly it cannot escape from his lungs in time to prevent bubbles forming, and he gets decompression sickness or 'bends' (caisson disease, compressed air illness), with severe pain, cramps, occasionally unconsciousness and even death. A diver can get severe bends coming up from a depth where the pressure is 4 atmospheres, to the surface where it is only 1 atmosphere, but fortunately an airman does not get into such serious difficulties if he goes from ground-level to one quarter ground-level pressure at 33,000 ft. Bends as they occur in the air are rarely experienced at altitudes below 25,000 ft. They come on slowly and are rarely of a serious nature. Unconsciousness can result if the warning symptoms of pain in the joints are neglected. The pains are cured almost instantly if descent is made to about 25,000 ft., where the air pressure compresses the bubbles sufficiently to drive them back into solution in the blood.

Much research has been carried out on men in decompression chambers to find ways of alleviating these effects. One method is to breathe pure oxygen before ascent so as to replace the nitrogen in the blood with oxygen. The oxygen is then used up in the tissues before it can form bubbles. This method has long been used to displace nitrogen from the blood while ascending from deep dives.

There are other disturbances to man with rapid changes of altitude resulting from the change in air pressure. The middle ear communicates through the eustachian canal with the throat and it is necessary for air to leave and enter it with ascent and descent lest the ear-drum be collapsed. The canal to the throat will normally open on swallowing, and in a dive a pilot clears his ears almost unconsciously; but should he fail to do so or have severe catarrh, he may damage his ear-drums. Enclosed gas elsewhere in the body, as in the sinuses surrounding the nose, has to equalize its pressure as the altitude changes or severe pain may result. Again, the gas normally present in the intestines expands to a larger and larger volume as the outside pressure falls when climbing, but this is rarely a serious practical problem.

Thus the human safety limit in height is some 10–16,000 ft. breathing air and 40–42,000 ft. breathing oxygen; heights much in excess of the latter are only achieved by enclosing the pilot in an artificial atmosphere.

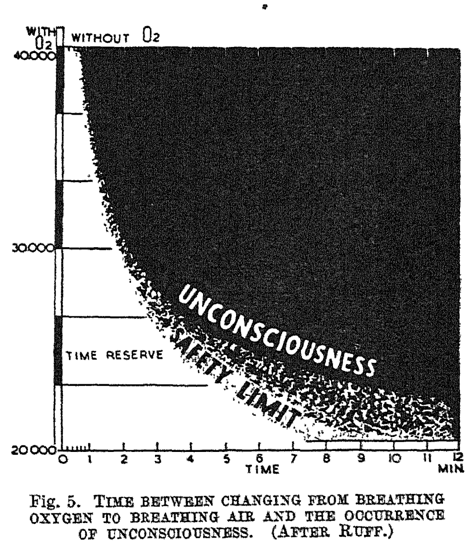

Fig. 5. Time between changing from breathing oxygen to breathing air and the occurrence of unconsciousness. (After Ruff.)

It is clear that, starting with fit pilots on the ground, much must be done to keep them efficient in the air, and the efficiency of the man may often be of even greater importance than that of the machine.

In the Battle of Britain quality in men and machines overcame weight of numbers, and although always greatly outnumbered, the R.A.F. by efficiency and courage were able to rout the Luftwaffe. To maintain that efficiency in the air and at high altitudes is no mean problem. That it is done is the result of scientific research during the last seventy years into life at great altitudes, and the successful application of what has been discovered to the particular problems of the pilot. I should like this lecture to be considered a tribute to all those scientific men, from Paul Bert onwards, and to many officers of the R.A.F. who have contributed so much to the solution of high-altitude flying, and in particular to those medical officers who have lost their lives in this War in flying experiments.

CONTROL OF OVULATION IN FARM ANIMALS

By JOHN HAMMOND, JUN.
School of Agriculture, Cambridge

WHEN Cole and Miller[1] obtained ovulation in ancœstrous sheep there was initiated a series of studies upon the application of gonadotrophins to the improvement of animal husbandry. It is the purpose of this article to sketch out the practical problems and the progress which has been made in overcoming them. It is not practicable to quote extensively, but many of the references to experimental work, upon which this account is based, are to be found in three papers in the *Journal of Agricultural Science*[2,3,4].

The nature of the control over ovulation which it may be desirable to exercise varies with the species and the economic circumstances. The problem may be to obtain matings outside the normal breeding season, or to improve fertility by increasing the number of ova shed at a normal heat, to regulate the interval between mating and ovulation, or to treat sterility due to cystic ovarian follicles. If a method of control is to be widely applied, it is necessary that the treatment be based upon materials which are available in large amounts and which are inexpensive to produce. Such preparations are at present limited to mare serum gonadotrophin, stilbœstrol and other synthetic œstrogens, and (available to a lesser extent) chorionic gonadotrophin and some pituitary extracts.

In the sheep, the natural breeding season falls in the autumn and winter months, but the length of the season varies considerably with different breeds, and in some, notably the merino and Dorset horn, it may extend over the whole or greater part of the year. The breed kept is determined by its suitability to local conditions, the relative value of the meat and wool crops, and, where rainfall is such that feeding conditions are good only in autumn or winter, mating has to be done in spring or summer, so that a breed with a long season is essential.

The incidence of twinning varies considerably from breed to breed; more especially it is low in the wool breeds. Specialized wool breeds are kept mainly in the more remote areas of the globe, and the lamb crop may be relatively unimportant; however, as meat storage and transport facilities are improved, it becomes of increasing value. When, as in Great Britain before the War, there is a price stimulus to the production of early lambs, or when seasonal conditions require it, the ram may be put with the ewes at the start of the breeding season. As some ewes come on heat earlier than others, the lambing season may then be prolonged and labour costs consequently increased. When the sheep are kept primarily for meat, the production costs include, besides the feeding of the lambs, the maintenance for a year of the ewes. The more lambs a ewe can rear the lower is the cost of production; it is certainly desirable that she should produce twins and, if the feeding stuffs are available, it may be of advantage to breed twice a year, which is not normally possible when the breeding season is restricted.

Thus in certain circumstances it may be of advantage to induce pregnancy in the normal ancœstrous period, to advance the onset of the breeding season or to increase the ovulation rate within the normal season. It is certain that by a policy of selection, twinning percentages could be much improved, and probable that, though with much more difficulty, the breeding seasons could be extended. Such methods, however, take a long time; meanwhile, hormone treatments offer a prospect of a rapid improvement in practice, pending the improvement in livestock which must be the ultimate aim.

In cattle the breeding season extends throughout the year, though there is a tendency for calving to shift to the spring. Heat periods tend to be shorter and less well marked in the winter, and there are two types of ancœstrus. In the first, ovulatory cycles continue, but heat is not manifested; in the second, a true ancœstrus, ovulation ceases and only small follicles are present in the ovaries; the latter state is almost entirely restricted to young animals in the winter months and under hard feeding conditions. The incidence of twinning is low, on the average well under 2 per cent, and is much lower in beef than in dairy breeds.

For milk production, calvings have to be spread over the year, and to maintain the winter supply a larger proportion must calve in the autumn months. This implies service in winter, when the ancœstrous condition is liable to develop. Sterility also causes large losses to the dairy industry, and a proportion of this is due to the formation of follicular cysts. Because in cattle the female twin to a male is usually a freemartin (imperfectly developed and sterile) twinning does not increase the number of animals which can be kept for breeding. In dairy cattle twins are not wanted, but in beef breeds they would be valuable for the same reason that applies to the mutton breeds of sheep. In areas where both beef and dairy cattle are kept, it is common for an extra calf to be bought for the cow to rear; however, the dairy-bred calf is a less efficient converter of feeding stuffs. In exclusively beef-producing areas there are, of course, no extra calves to buy.

The breeding season of the mare falls in spring and summer; persistence of ancœstrus causes some difficulty, and some sterility is due to development of cystic follicles, which may be associated with spiteful behaviour. The most important feature is, however, the low proportion of services which are fertile; this is attributable to the length of œstrus relative to the survival time of sperm. Ovulation occurs about a

day before the end of heat, and early in the season heat periods may sometimes last several weeks. With heavy horses a stallion may be available only once a week, so mating cannot be arranged at the optimum time even when the time of ovulation can be estimated.

The number of goats kept has increased during the War; partly because of milk rationing, partly because of the great variety of roughages upon which they will subsist. The breeding season is restricted, as in the sheep, and the gestation period is five months, so the peak of lactation cannot, with normal mating, be arranged to fall in winter when the milk ration is lowest. Mention must also be made of the pig. No work appears to have been done on the control of reproductive processes in this species. A method of increasing fertility would be valuable in some breeds, but the proper approach to this is probably the reduction of fœtal atrophy rather than increasing the number of ova shed.

In the mare and the cow, the condition of the ovaries can be ascertained by palpation per rectum. The structure of the ovary in the mare does not permit recognition of the corpus luteum, except in its early formative stages; but in the cow it is easily distinguished and can be removed by pressure without difficulty. After expression of the corpus luteum, heat and ovulation follow in about four days, and the cycle thus begun is of normal length. In the other species mentioned, the condition of the ovaries will depend upon the breed, age, time of year and time of the last heat period; it is probable also that nutritive conditions considerably affect the amount of follicle development. There is little precise information on these points. Year-old sheep (Suffolk and Suffolk crosses) killed in Cambridge are usually found to have well-developed follicles at all times in anœstrus; isolated ovulations are occasionally observed. The state of the ovaries during lactation is not known.

Mare serum gonadotrophin and follicle-stimulating pituitary extracts will cause follicle growth, followed by ovulation, in anœstrous sheep. The first ovulation of the breeding season in sheep is not normally accompanied by heat, and this also applies to gonadotrophin-induced ovulation. Injection of mare serum gonadotrophin combined with artificial insemination may lead to pregnancy; but as yet this has been achieved in only a small proportion of the treated animals. The number of ovulations is normal and seems, except possibly for very high doses, to be unrelated to the amount of gonadotrophin given. Treatment with stilbœstrol and other œstrogens will cause heat, and in some cases, probably those animals with larger follicles, also leads to ovulation. When stilbœstrol and mare serum gonadotrophin are given together it appears the œstrogen may sometimes inhibit the ovulation which would be obtained with the gonadotrophin alone; often with œstrogen the time relationships of œstrus and ovulation have been such as to render fertilization improbable.

If a second follicle-stimulating treatment is given after an interval of about sixteen days (the normal cycle-length in sheep), heat and fertile service often follow. An induced ovulation is sometimes followed, a cycle later, by spontaneous ovulation together with heat. The difficulty may be encountered in the summer that the ram is not at all keen. The numbers coming on heat after a double treatment have, in trials, varied greatly from flock to flock and year to year; the proportion of services fertile is lower than in the breeding season. Results tend to be best with fifteen-month-old animals and poorest with suckling ewes. Much remains to be done before commercial application is possible.

The goat appears to differ from the sheep in that about half come on heat a few days after a single injection of mare serum gonadotrophin[5]; the proportion of services which are fertile is lower than in the breeding season. In anœstrous heifers, only small follicles are present in the ovary, and stilbœstrol does not induce ovulation, though, of course, it produces signs of heat. Mare serum gonadotrophin and horse pituitary have been found to cause follicle growth followed by ovulation in the majority of animals, though a small proportion fail to respond. Heat is not always shown and tends to be short and not well marked; in those served, the frequency of conception seems to approach the normal figure. In the mare, it is noteworthy that mare serum gonadotrophin, characteristically follicle-stimulating, has no apparent effect on the anœstrous ovary[6], and at present there is no practicable and effective treatment.

In the breeding season, the presence and influence of the corpus luteum may be responsible for a different response to treatment from that found in anœstrus. In sheep and cattle, the luteal phase occupies nearly the whole of the cycle. Stilbœstrol given in mid-cycle will produce signs of heat, but usually without willingness to accept the male, and the rhythm of the cycle is unaffected. Chorionic gonadotrophin will cause ovulation in the presence of a corpus luteum, follicle-stimulating preparations may sometimes do so, but not generally. Usually the cycle rhythm is unaltered; the corpus luteum formed when ovulation is induced in mid-cycle persists only as long as that already present in the ovary. If gonadotrophin is given shortly before the corpus luteum degenerates, the follicles developed, but previously restrained from ovulating, do so at the next heat period. In this way an increased ovulation-rate is obtained. In sheep, this has been confirmed by several workers, and multiple pregnancies have been so produced; practical trials have, however, given very disappointing results.

In the cow, multiple ovulations and calvings have been obtained in this way with mare serum gonadotrophin. They may also be obtained by injection of this gonadotrophin earlier in the cycle, followed by expression of the corpus luteum, the number of ovulations varying with the dosage and the interval between injection and removal of the corpus luteum. Little has yet been done to determine how closely the number of ova shed can be controlled, but it seems, at least when a single injection is given, that the corpus luteum removal method may be not sufficiently dependable, and the end of cycle injection may be satisfactory if the time for treatment can be properly judged. The former method requires only a rectal examination, the latter that the cow be seen on heat previously; with beef cattle it is usual for the bull to be run with the herd, and heat is not well marked. An increased frequency of double ovulations has been noted in cattle after treatment with stilbœstrol implants[7], so it may be possible to evolve a method of increasing the ovulation-rate by the use of œstrogens.

Lastly, mention should be made of conditions in which there is a large follicle present and no active corpus luteum. After rupture of a cystic follicle in the cow, a follicle usually matures but, failing to

ovulate, also degenerates into a cyst. If this follicle is ruptured early, it undergoes luteinization and the normal cycle is resumed. Chorionic gonadotrophin, at least in some cases, will cause ovulation of such follicles[6]; this treatment may be useful because it can be given by one without the necessary skill in rectal examination. Chorionic gonadotrophin given to œstrous mares having a large follicle induces ovulation within about twenty-four hours; prolonged œstrous periods are thereby terminated and matings can be arranged accordingly.

In this short account, it has been convenient to give only a few references, mostly English; it is therefore well to point out that much work in this field, particularly early attempts at application to sheep breeding, has been Russian, most of the remainder being done in the United States and Great Britain.

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[2] (Mare) Day, F. T., *J. Agric. Sci.*, **30**, 244 (1940).

[3] (Sheep) Hammond, jun., J., Hammond, J., and Parkes, A. S., *J. Agric. Sci.*, **32**, 308 (1942).

[4] (Cow) Hammond, jun., J., and Bhattacharya, P., *J. Agric Sci*, **34**, 1 (1944).

[5] Williams-Ellis, C., personal communication.

[6] Day, F. T., personal communications.

[7] Hammond, jun., J., and Day, F. T., *Endocrinol.* (in the Press).

THE STATISTICAL LAW IN NATURE

By Prof. ERWIN SCHRÖDINGER

Dublin Institute for Advanced Studies

LUDWIG BOLTZMANN was born in Vienna in 1844. Of the Austrian tetrad of brilliant physicists (Loschmidt, Stefan, Mach, Boltzmann) he duly gained widest fame. I could begin by telling of the splendid, at that time daring, proof he gave of the fundamental law of radiation, by imagining a pintful of nothing to undergo a sequence of compressions and dilatations—a so-called Carnot cycle. I could tell of his grinding a crystal of sulphur to the shape of a neat marble, that was to serve him in an experimental confirmation of Maxwell's theory of electricity, of which he was one of the foremost champions on the Continent. But to indicate what he really meant to the development of human thought, I must start from a wider basis.

In the course of the last sixty or eighty years, statistical methods and the calculus of probability have entered one branch of science after another. Independently, to all appearance, they acquired more or less rapidly a central position in biology, physics, chemistry, meteorology, astronomy, let alone such political sciences as national economy, etc. At first, that may have seemed incidental: a new theoretical device had become available and was used wherever it could be helpful, just as the microscope, the electric current, X-rays or integral equations. But in the case of statistics, it was more than this kind of coincidence.

On its first appearance the new weapon was mostly accompanied by an excuse: it was only to remedy our shortcoming, our ignorance of details or our inability to cope with vast observational material. In the study of heredity we might prefer to be able to record the individual processes of meiosis, and thus to know how the hereditary treasure of a particular individual is composed from those of its grandparents. In text-books on gas-theory it has become a stock-phrase, that statistical methods are imposed on us by our ignorance of the initial co-ordinates and velocities of the single atoms—and by the unsurmountable intricacy of integrating 10^{23} simultaneous differential equations, even if we knew the initial values.

But inadvertently, as it were, the attitude changes. It dawns upon us that the individual case is entirely devoid of interest, whether detailed information about it is obtainable or not, whether the mathematical problem it sets can be coped with or not. We realize that even if it could be done, we should have to follow up thousands of individual cases and could eventually make no better use of them than compound them into one statistical enunciation. The working of the statistical mechanism itself is what we are really interested in. It adds nothing to our outlook to know whether a particular (male) fly owes a specified portion of its X-chromosome to its mother's father or to its mother's mother. The relevant fact is, that one or the other must be the case and that one is as likely as the other.

I dare say the first scientific man aware of the vital role of statistics was Charles Darwin. His theory hinges on the law of big numbers. He had not to resort to heavy mathematics; common sense is sometimes an admirable substitute. It will be remembered how untiringly Darwin emphasizes again and again the enormous geometrical progression of virtual offspring and the enormous destruction of actual offspring that must be inferred therefrom. This, indeed, is the statistical mechanism which makes practically and safely operative the very small increase in chance of survival that a small favourable variation entails.

More drastically than any other science, physics has promoted the statistical aspect from an ancillary service to the domineering role of indicating the goals and pointing out the pathways. It was a revolutionary step, affecting virtually the whole house of science, inasmuch as it is ultimately based on physics. The names of L. Boltzmann and W. Gibbs are representative of that discovery. Only five years in age separated these two men, of whom Gibbs was the older; but the Atlantic lay between them, and I do not know that they ever met. Yet so parallel ran their thought, that to us it almost coalesces. It involved a new outlook on the nature of the laws of Nature; namely, that they are not rigorous laws at all, but 'only' statistical regularities, based on the law of great numbers, just as Darwin's theory is*.

Among the laws of physics *one* has quite a unique standing, the so-called Second Law of Thermodynamics. By enunciating (in a sense not to be detailed here) the *perpetual increase of entropy*, it safeguards a one-way traffic of physical events. Nothing could ever happen in exactly the opposite way it does happen, because that would involve a decrease of entropy. No substantial part of the world can ever be made to run backwards, as you could do with an ideal, purely mechanical clock-work (which, of course, does not exist). The Second Law embodies the unidirectional trend, the irreversibility in the course of Nature.

It would scarcely be satisfactory to account for this remarkable fact by inventing some special device, to be attributed as a common feature to all the

* If the nineteenth century is going to be named after any one man, said Boltzmann in 1886, it will be called the century of Darwin.

multifarious 'mechanisms' in Nature. According to Boltzmann, this is not necessary. The Second Law rests on—nay, it *is*—statistics; it is the pure embodiment of the statistical law itself, nothing else. Events move in the direction in which they are most likely to move. Heat flows in the direction of temperature fall, because it is billions of billions times less likely to do anything else.

The philosophical implication can scarcely be overrated. Forces, charges, potentials, collisions—the whole armoury of detailed mechanisms we invent—are apt to retain, in spite of all our striving for the contrary, a slightly mystic tinge or at least much arbitrariness. Boltzmann's discovery, though it cannot entirely dispense with this armoury, assigns to it the rank of an auxiliary device. Our true understanding of what happens is reduced to reasoning about *whole numbers*. We are able to predict the course of events, because we are able to count: one, two, three four, . . . so we can count the eventualities of every thinkable turn and find out the one that is overwhelmingly likely.

That the probability is, as a rule, next to certainty —in other words, that the laws of Nature are next to infallible—is due to the enormous number of single atoms or single microscopic events that co-operate. Whenever this number is not 'enormous', deviations must be expected. From the very year of Boltzmann's tragic death (1906) experimental evidence about these 'thermodynamic fluctuations' began to spring up abundantly, confirming quantitatively the conclusions from his theory, none of which has ever failed.

In the long run, even very improbable things are bound to happen. Given an infinity of time, a physical system would return occasionally even to a very improbable state. Strangely enough, the overwhelmingly most probable manner of accomplishing the—in itself extremely improbable—return is by an *exact* reversal in time of a common process, one following the ordinary laws of physics as we know them. In a word, *sub specie æternitatis*, past and future become equivalent—there is no 'arrow of time'. Future may mean nothing more than just that one of the two directions of time in which entropy does increase—in our time and for some time before and after. This curious result, of which a momentous effect on our world-picture may still be in store, is the inevitable outcome of sober mathematics, not a wilful day-dream.

While many a page in Boltzmann's books and scientific papers is witness to his unusual, slightly capricious, but very lovable human personality, the most attractive means of reconstructing it is offered by the slim volume of his popular writings[1]. I wish I could use up another column or two in quoting from these enjoyable essays. "A German Professor's Voyage to the Eldorado"—describing a visit to California—is a gem in light literature (the use of "German" in the purely cultural connotation was, of course, current in Vienna). The new topic of aeronautics, the objective existence of the world around us, controversies on the ill-famed German 'energetics', Beethoven's symphonies, America's university life and queer temperance laws, and scores of other subjects are dealt with in this volume in a pleasing conversational tone by one who was a man, take him for all in all—with a candid soul, a sincere and interesting mind, whatever else he might have been.

[1] Boltzmann, L., "Populäre Schriften" (Leipzig: J. A. Barth, 1905).

OBITUARIES

Mr. H. N. Dixon

HUGH NEVILLE DIXON was born at Wickham Bishops, Essex, on April 20, 1861, and died at Northampton on May 9, 1944. He was educated at Christ's College, Cambridge, where he studied classics, taking a first in the Classical Tripos in 1883; he later obtained a London M.A. On leaving Cambridge he went to assist the Rev. Thomas Arnold, who had a school for the deaf at Northampton, which his brother attended; he succeeded as head of the school in 1884, retiring in 1914. He was an active Congregationalist serving on many committees, and was a director of the London Missionary Society.

In 1886, Dixon became secretary of the Northamptonshire Naturalists' Society and Field Club and took an active part in its affairs until his death, continuing as secretary until 1931. An all-round naturalist, he was mainly interested in mosses. His first paper, "Northamptonshire Mosses", appeared in the *Journal of Botany* for 1884, and was preceded by a note on "New Localities for Rare Mosses" which gave evidence that his interest dated from his Cambridge days. Then, until the end, there was a steady stream of papers, first on British and European mosses, and then those of various expeditions to different parts of the world until he became, and was regarded as, one of the foremost authorities on the group. He is best known to students by his excellent "The Student's Handbook of British Mosses", which was published in 1896, with further editions in 1904 and 1924. This was illustrated with drawings by the Rev. H. G. Jameson, who also drew up keys to the genera and species. This is the standard Flora and is likely long to remain so. His only other book is "Studies in the Bryology of New Zealand", which appeared in parts during 1913–29 and has "special reference to the herbarium of Robert Brown", the shoemaker bryologist of Christchurch.

With so many calls on his knowledge Dixon might well have pleaded inability to give assistance to those struggling with identifications of common British mosses; but it was characteristic of him that he always gave unstinted assistance and encouragement. He joined the Moss Exchange Club on its formation in 1896, and when it was converted into the British Bryological Society in 1923, he was appropriately elected as the first president: he had produced a "handbook" catalogue of British mosses for use of members in 1897.

H. N. Dixon was quiet and unassuming, of wide learning and, except where his principles were offended, a man of peace. He was fond of sketching, and wrote quite pleasing verse. Few, until they knew him well, realized his store of energy; he was an adept at skating, played hockey until he was more than fifty, climbed Snowdon three times in one day, and Skiddaw on his eightieth birthday—with alpine climbs to his credit; and walked from Northampton to Leamington, Kenilworth and Coventry—55 miles in one day.

Dixon's health did not begin to fail until this year. So late as March he read a short paper before the Linnean Society on "The Phytogeographic Relations of Sumatran and other Alpine Mosses"—and was engaged on naming some British Museum collections when he became ill. Thus for sixty years H. N. Dixon published a long series of important papers on the taxonomy of mosses, and his name is writ large in

the annals of bryology. He served on the Council of the Linnean Society during 1925–29, and was vice-president in 1928. He was honorary member of several natural history societies, but none of the recognized honours came his way. Perhaps it was because taxonomy, not being in the fashion, is not 'original research'—perhaps it was because he was over-modest. He has bequeathed his British collection to the Kew Herbarium and his foreign collection to the British Museum (Natural History). J. RAMSBOTTOM.

WE regret to announce the following deaths:

Prof. J. G. Duncan, lecturer in chemistry in the Royal Technical College, Glasgow, and professor of chemistry at the Veterinary College, Glasgow, on May 1.

Prof. Chancey Juday, emeritus professor of limnology and director of the Limnological Laboratory at the University of Wisconsin, president in 1927 of the Ecological Society of America, on March 29, aged seventy-two.

NEWS and VIEWS

University Chair of Geography: Birkbeck College

Prof. E. G. R. Taylor

THE retirement of Prof. Eva G. R. Taylor from the University chair of geography at Birkbeck College, London, marks the departure from active academic life of one of the most vigorous personalities in geography. After graduating in natural sciences in London, she became personal assistant to Prof. A. J. Herbertson at Oxford at a time when he and his contemporaries—including Halford Mackinder and H. R. Mill—were laying the firm foundations of the modern concept of geography. A period of lecturing in London teachers' training colleges followed by ten years association (1921–31) with Prof. J. F. Unstead at Birkbeck College gave opportunities, both through lively teaching and lecturing and the well-known series of Unstead and Taylor text-books, for disseminating the new ideas in the minds of successive generations of prospective teachers. Prof. Taylor preferred always to work under her maiden name, but geographical work had to be combined in these years with the urgent needs of a young family; nevertheless she found time for a thoughtful little book on "Oceans and Rivers", and in her own text-books developed the now universally familiar idea of the 'sketch-map'—more adequately described as a cartogram in which certain salient or related features are selected for diagrammatic representation on an outline map.

Prof. Taylor's appointment in 1931 to succeed Prof. Unstead gave opportunities for a wider sphere of work. Earlier years of patient research in historical geography led to the successive publication of a study of Barlow's "Brief Summe of Geographie", comprehensive works on Tudor geography and on Late Tudor and Early Stuart geography and on the writings of the Hakluyts. Papers on old maps and instruments appeared in the *Mariners Mirror* and many other journals. In 1937 came the great opportunity to bring before a wider public the geographical concept of the influence of environmental factors in the life of man. The Royal Geographical Society was asked to prepare evidence for the Royal Commission on the Geographical Location of the Industrial Population (the Barlow Commission) and Prof. Taylor acted as chairman of the committee which, by a large series of maps and diagrams yet to be incorporated in the proposed National Atlas, succeeded in demonstrating both the strength and permanence of such localizing factors as accessibility, relief of the land, distribution of minerals, soil, rainfall, temperature, fog and a host of others on the distribution of industry and the movement of the population. She showed the dangers of the growing concentration of industry and population in a central coffin-shaped area stretching from Lancashire to Greater London—with the consequent creation of peripheral depressed areas. With Dr. Dudley Stamp she represented the Society and gave verbal evidence to the Commission the influence of which is apparent in both the Barlow Report and the subsequent Scott Report, as well as in what is now current day-to-day practice in town and country planning. It is greatly to be hoped that Prof. Taylor's retirement will in reality mean greater leisure for continuance of constructive work.

Prof. S. W. Wooldridge

DR. S. W. WOOLDRIDGE, who has been appointed to succeed Prof. Taylor, was trained as a geologist. He took as his special field the minor structures and glacial history of the London Basin, to which much of his published work relates. The climatic implications of glaciation drew him to a study of meteorology under the stimulating guidance of Sir Napier Shaw, and, thus equipped, it was natural that he should be invited to lecture on the physical basis of geography to the newly formed Honours School of Geography at King's College and the London School of Economics. Dr. Wooldridge's attention was thus turned to human geography, concerning which its critics said that its conclusions were either trivial or fallacious. To test this view, he examined the archæological and historical material relating to the entry phase of the Anglo-Saxon settlement in the light of his geomorphological researches, and was able to demonstrate, *inter alia*, the important influence of the loam terrains. His published papers on this theme strengthen the view that the weakness of human geography has arisen rather from the insufficient refinement of the analysis of physical conditions than from the unimportance of the geographical factor. At Birkbeck College Dr. Wooldridge will find a considerable body of postgraduate students, many of whom are at work on geographical aspects of regional and national planning. The importance of a close scrutiny of the terrain in this connexion needs no emphasis.

Ardaseer Cursetjee (Wadia), F.R.S.

FEW men of science in Great Britain know that an Indian, Ardaseer Cursetjee (Wadia), was admitted into the fellowship of the Royal Society so early as 1841. The following information was given to Prof. A. V. Hill, biological secretary of the Royal Society, by Colonel S. L. Bhatia, of the Indian Medical Service, who obtained details from Sir R. P. Masani of Bombay. In the *Journal of the Royal Asiatic Society* of 1865 he appears as "Ardeseer Cursetjee, Esquire, of Bombay" and as the first Indian elected a fellow of

the Royal Society in the records of that Society. There is corroboration in "History of the Lodge Rising Star of Western India" by D. F. Wadia. "It was at the very meeting (of the Lodge) held at the Town Hall on 15 December 1843, that four gentlemen were proposed for initiation to be ballotted for at the next meeting. They were Mr. Ardeseer Cursetjee Wadia (the first native gentleman admitted a Fellow of the Royal Society, who had a great engineering reputation and was at this time Chief Engineer in the Government Dockyard) and Messrs. Mirza Ali Mahomed Shoostry, Hajee Hasham Ishphanee and Mahomed Jaffer, who were leading Mogul Mahomedan merchants of the day."

In 1822 Ardaseer Cursetjee (Wadia) served under his father in the Government Dockyard and became assistant builder. In 1833 he built a small steamer, the *Indus*, in the Mazagon Dock and personally fitted up all machinery. He is reported to have made experiments in connexion with gas lighting and to have fixed up all pipes and gas machinery in his bungalow at Mazagon, Bombay; and it is recorded in Parsi annals that the Earl of Clare, Governor of Bombay, inspected the installation on March 10, 1834, and gave him a 'Dress of Honour'. In 1836 he was appointed non-resident member of the Royal Asiatic Society of Great Britain and Ireland. In 1839 Ardaseer Cursetjee (Wadia) went to England for further studies in mechanical engineering. There his services were engaged by the court of directors of the East India Company in the workshop of Messrs. Wards and Keppel. The chronicles further state that he was presented to Queen Victoria on July 1, 1840, and that he thereafter published a book of his notes regarding his travels in England. He returned to Bombay in 1841 and was appointed chief engineer of the Steam Factory and Foundry. In 1849 he was elected vice-president of the Mechanics Institute. He went to England for the second time in 1851; was made a Justice of the Peace in 1855, and retired on pension on August 1, 1857. In 1859 he went to England for the third time; and in 1861 he was appointed chief resident engineer of the Indus Flotilla Company at Karachi, and there he built three or four steamers navigating the Indus. In 1864 he went to England for the fourth time and remained there until his death on November 16, 1877, at the age of seventy.

'Marfanil'

LITTLE has been gleaned, according to the *Lancet* (635, May 13, 1944), from a close watch on German medical publications and practice during this War; but an exception is 'Marfanil', formerly known as 'Mesudin', which is 4-amino-methyl-benzene sulphonamide. It differs from the other common sulphonamides in having the amino group separated from the benzene ring by a methyl group. It is now extensively used in the German army for local application to wounds, being issued as a powder; the powder is used either alone or diluted with nine parts of sulphanilamide. Tablets of equal parts of 'Marfanil' and sulphanilamide are also used. A quantity of the drug captured in North Africa has been tested clinically by three R.A.M.C. officers, Lieut.-Colonel G. A. G. Mitchell, Captain W. S. Rees and Captain C. N. Robinson, who give their results in the same issue of the *Lancet*. They say that no other substance that they have tested has given better results, except penicillin; and they suggest that penicillin used in conjunction with 'Marfanil' may give better results than penicillin mixed with sulphanilamide or sulphathiazole. The anti-bacterial action of 'Marfanil' is not inhibited by pus or other wound discharges. It is almost non-irritating, and is no more toxic than sulphanilamide. It does not destroy epithelium or prevent its growth. It is evident from the other features of this drug discussed by the *Lancet* that further study of it would be profitable. It is, unfortunately, largely inactivated in the blood and is therefore not suitable for systemic administration; but it should not be beyond the skill of chemists to overcome its other drawback, namely, the difficulty of producing it in quantity.

Herbs and Medicinal Plants

DURING the past year, the *Brooklyn Botanic Garden Record* (32, Nos. 1 and 3) included two attractive Guides (Nos. 15 and 16) to the Herb and Medicinal Garden which was opened in 1938. The provision of a medical plant garden was considered justified in view of the large number of plant drugs in use in spite of the recent increase in the number of 'chemical' and 'biological' substances utilized in medical practice. Guide No. 16 includes a survey by A. H. Graves of the use of plants in medicine from Greek times up to the present day, which illustrates the growth of our knowledge from the relatively advanced outlook of the Greeks, through the period clouded by superstitions of the early Middle Ages, finally to the very marked advances of modern times. This survey is written in a style to attract the interest of general and scientific readers, and is illustrated by numerous woodcuts of the activities of the early herbalists. The historical survey is followed by an account by Prof. C. W. Ballard of Columbia University, and collaborators, of the medical uses of the species commonly regarded as drug plants. In the case of some of those officially recognized in the United States Pharmacopeia or the National Formulary, such as *Aloe vera, Ephedra equisetina, Atropa belladonna*, etc., some indication of the amount used annually and the possibilities of home cultivation within the United States receive comment. In the case of some imported plant drugs, the shortage caused by the present crisis has indicated clearly that the encouragement of home cultivation of the plants and their study with a view to possible synthesis of the medicinal constituents is a matter worthy of serious consideration.

Vesalius and the Struggle for Intellectual Freedom

IN an address delivered before the Washington Academy of Sciences on November 18, 1943, on the occasion of the four hundredth anniversary of the publication of Vesalius's "De humani corporis Fabrica" (*J. Wash. Acad. Sci.*, 34, 1; 1944), Prof. Howard W. Haggard, of Yale University, sees the great classic of human anatomy as less important for its merely technical contents than for its significance in the struggle for intellectual freedom, for the liberty of scientific thought against tradition and authority. Reviewing the progress of medical knowledge through the centuries, he shows that the authority of Galen had helped to blind even competent observers to the facts revealed on the dissecting table until Vesalius published his great book in 1543. Prof. Haggard deals also with the main facts and incidents in the life of Vesalius, and his tragic death from an unknown disease when shipwrecked on the island of Zante on returning from a pilgrimage

to the Holy Land and on his way to resume his old chair of anatomy in Padua. There is also a reference to another tragedy, that of Servetus, "who, for a theological quibble, was burned at the stake by order of Calvin and whose books were burned with him"—a crime of bad faith that still sends a cold shudder through the sensitive reader.

New World Prehistory

A PAMPHLET entitled "Cross Sections of New World Prehistory: a Brief Report on the Work of the Institute of Andean Research, 1941–42", by Wm. Duncan Strong, professor of anthropology at Columbia University, has been issued (*Smithsonian Misc. Collections*, 104, No. 2). The fields covered by the various investigators include eastern and western Mexico, El Salvador, Venezuela and the West Indies, Colombia, Ecuador, various districts in Peru and the northern coast of Chile. Naturally the information from such a wide area of the Americas that can be given in some 42 pages accompanied by 33 plates is not very extensive; but a general survey like this is of value, and the large relative chronological chart from A.D. 100 to A.D. 1500 will doubtless prove useful to students more interested in the general prehistory of Central and South America than in its details. There is also a map showing the general location of the excavations undertaken by the Institute.

Remote Switching by Superimposed Currents

A PAPER was read on this subject in London recently before the Institution of Electrical Engineers by J. L. Carr, in which the author briefly reviewed the methods employed for the centralized control of switching operations on distribution networks, by the injection into the distribution system of currents the frequencies of which differ from that of the main supply. The superimposition of ultra-audio frequencies for limited and specific purposes, such as the protection or the remote switching of a transmission line, has not, so far, been employed to any large extent in Great Britain, and is therefore not considered. Several devices employed to respond to injection currents are briefly described, and the probable applications of this method of control are outlined. Particulars of the development of remote signalling over the network of a large electricity supply undertaking are given, together with reasons for the final adoption of the method selected. Data of the components of the equipment are given, and the power required is analysed for two frequencies.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has found the epicentres of three recent earthquakes. On January 10 at 20h. 10·0m. G.M.T., an earthquake had its epicentre in Mexico near lat. 18·1° N., long. 100·6° W. It was recorded throughout America and as far north as Sitka in Alaska. On January 15 at 23h. 49·4m. G.M.T., an earthquake had its epicentre in the Argentine near lat. 31·5° S., long. 68° W. It was recorded throughout America as far north as Alaska and at Honolulu. On February 3 at 12h. 15·2m. G.M.T., an earthquake had its epicentre in south-eastern Alaska near lat. 59·3° N., long. 138·0° W. This was recorded by seismographs at Buffalo, Burlington, Chicago, Fordham, Georgetown, Honolulu, Pasadena, Philadelphia, Sitka and Tucson.

Lunar Eclipses and the Earth's Atmosphere

Sky and Telescope of January 1944 has a short notice with the above title, which describes the photometric results of the lunar eclipse on March 2–3, 1942. These results were obtained in France by Daniel Barbier, Daniel Chalonge and Ernest Vigroux, and indicated, in accordance with the theoretical predictions by Link, a relationship between the intensity of the ozone bands and the distance from the centre of the shadow. Future spectrophotometric studies of lunar eclipses may yield new information on the earth's upper atmosphere.

Physical Society

AT the annual general meeting of the Physical Society held on May 24 the following were elected or re-elected for 1944–45: *President*, Prof. E. N. da C. Andrade; *New Vice-President*, Sir Edward Appleton; *Hon. Secretaries*, Mr. J. H. Awbery (Papers) and Dr. W. Jevons (Business); *Hon. Treasurer*, Dr. C. C. Paterson; *New Members of Council*, Prof. S. Chapman, Mr. C. H. Collie and Prof. H. R. Robinson. At an extraordinary general meeting held on the same day A. F. Joffe was elected an honorary fellow of the Society. The officers of the Colour Group for 1944–45 are: *Chairman*, Mr. J. Guild; *Hon. Secretary*, Dr. W. D. Wright. The officers of the Optical Group for 1944–45 are: *Chairman*, Prof. A. O. Rankine; *Hon. Secretary*, Prof. L. C. Martin.

Announcements

PROF. A. V. HILL, biological secretary of the Royal Society, has been awarded the Joykissen Mookerjee Gold Medal for 1944 of the Indian Association for the Cultivation of Science.

SIR ARDESHIR DALAL, director in charge of the Tata Iron and Steel Co., Ltd., has been appointed a member of the Executive Council of the Governor-General of India, and will be in charge of a newly formed Department of Planning and Development.

Dr. B. A. Keen and Dr. E. B. Worthington, the two British members of the Scientific Advisory Mission to the Middle East Supply Centre, who have been travelling extensively in the Middle East territories for the past seven months, have returned to England for consultations at the Ministry of War Transport in connexion with their draft report and recommendations.

THE American Association for the Advancement of Science will hold its annual meeting for 1944 at Cleveland, Ohio, during September 11–16. Two previous annual meetings have been cancelled at the request of the U.S. Office of Defense Transportation.

AT the annual general meeting of the Institute of Physics held on May 22 the following were elected to take office on October 1: *President*, Sir Frank Smith; *Hon. Treasurer*, Major C. E. S. Phillips; *Hon. Secretary*, Prof. J. A. Crowther.

THE Summer School in Social Biology arranged by the British Social Hygiene Council to be held in Bangor (see NATURE, March 25, p. 373) has been cancelled.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Relaxation Processes in Statistical Systems

THE difficulties besetting the so-called 'foundation of statistics', that is, the establishment of the connexion between statistics and mechanics, reduce, as is well known, to two fundamental points of an entirely different nature.

The first difficulty is connected with the introduction into mechanics of probability conceptions, which constitute the essential feature of statistical physics, for example, of its fundamental assertion, the H theorem. The second difficulty consists in the mechanical specification of those systems to which the results of statistical mechanics can be applied.

To the first group belong all the problems of a mechanical interpretation of irreversibility, all the well-known objections against Boltzman's treatment of the H-theorem. To the second group belong the investigation of ergodical properties, which have met with but very meagre success in reaching the goal set by statistical mechanics. In spite of a number of accessory results—eventually extremely important ones—obtained in the attempts to overcome these two difficulties, the problem of establishing the connexion between statistics and mechanics must be considered as wholly unsolved thus far.

In fact, all these points of view, which were based on classical mechanics (Boltzmann, Ehrenfest, Mises, Rosenthal and others), are in principle incapable of overcoming the first of the above difficulties: all attempts to introduce into the classical mechanics the probability concept lead to inner contradictions. This circumstance is expressed by the fact that the mechanical process cannot be subjected to the probability scheme of Markoff's chains (Hadamard). (In particular, the interpretation of the H-theorem with the help of Boltzmann's famous saw-like curve proves to be self-contradictory.) On the other hand, investigations based on classical mechanics (numerous investigations of mechanical ergodicity carried out in recent years) have led to problems of unsurmountable complexity in the way of removing the second difficulty; in the first place, it turns out that mechanical ergodicity is quite insufficient for statistical purposes—and, in particular, for the definition of the fundamental notion of relaxation; in the second place, the results of investigations on ergodicity did not enable one to specify those systems to which the corresponding mathematical definitions should be applicable.

At the same time, attempts to solve the question based on quantum mechanics (Neumann, Klein, Pauli, Fierz and others) left the second difficulty altogether aside, referring to the model of irreducibility only. But even in this respect they could not reach their goal: the connexion between the microscopic and the macroscopic notions, indicated by them, remained unsatisfactory. Investigations based both on the classical and on the quantum point of view thus could not introduce the notion of the relaxation of a system, which is the fundamental notion of statistical physics: they not only did not give—even in principle—a method for a quantitative determination of the relaxation time, but left the notion of relaxation devoid even of a qualitative definition through the mechanical characteristics of the system. They were, accordingly, quite unsatisfactory.

In the present investigation, the notion of ergodicity is ignored. I reject the ergodical hypothesis completely: it is both insufficient and unnecessary for statistics. I use, as starting point, the notion of motions of the mixing type, and show that the essential mechanical condition for the applicability of statistics consists in the requirement that in the phase space of the system all the regions with a sufficiently large size should vary in the course of time in such a way that while their volume remains constant—according to Liouville's theorem—their parts should be distributed over the whole phase space (more exactly over the layer, corresponding to given values of the single-valued integrals of the motion) with a steadily increasing degree of uniformity.

It is possible to state the general condition which must be satisfied by the potential energy of the system for the latter to belong to the mixing type. The main part of this condition consists in the requirement that the curvature R of the Riemann space of Jacobi's variational principle, corresponding to the mechanical problem and expressed by the formula

$$R = -\frac{1}{hw^2}\Delta w - \left(\frac{1}{4} - \frac{3}{2h}\right)\frac{1}{w^3}\operatorname{grad}^2 w,$$

where $w = A\ (\varepsilon_0 - u)$, ε_0 is the total energy of the system, u its potential energy, A a certain constant, n the number of degrees of freedom, Δ and grad being defined in the n-dimensional configuration space[1], should be negative; or, more exactly, that the regions with a positive curvature should be sufficiently small. This condition is actually fulfilled in all the practically important cases of the application of statistical physics.

The main condition of mixing, which ensures the fulfilment of this condition, is a sufficiently rapid divergence of the geodetic lines of this Riemann space (that is, of the paths of the system in the n-dimensional configuration space), namely, an exponential divergence (cf. Nopf[1]).

Measurements of macroscopical systems, considered in statistical mechanics, refer to a region of phase space with a volume $A^n \gg h^n$ (this is due, besides the quantum character of the measurements, to the macroscopic character of the systems). The notion of probability penetrating all the statements of statistical mechanics arises as a result of the impossibility of specifying the state of the system as a point in the phase space. The change of the distribution function of the system is determined by the law of spreading of the points of the initial region over the whole surface of the given values of the single-valued integrals of the motion: the probability of finding the system at a time t after the initial experiment in a certain macroscopic state is defined by the fraction of the points of the initial region, which at the instant t are situated within the region, corresponding to this macroscopic state. In the presence of mixing, this circumstance ensures the fulfilment of all the probability requirements of statistical physics (of the H-theorem, of Schrödinger's reversibility of the macroscopic equations with respect to the time, etc.). The relaxation process can be visualized as the process of the mixing—the mixing of the initial region, corresponding to the original

non-equilibrium state, over the whole surface of given values of the single-value integrals of the motion. The relaxation time is defined as the time of this mixing, that is, the time during which a mixing with such a degree of uniformity is reached as corresponds to the type of the control macroscopic measurement, that is, to the accuracy of the experiment checking the establishment of equilibrium. The relaxation time depends, in general, on the type of the original fluctuation. The largest value of the relaxation time can be defined as the time of mixing of an initial region with a volume A^n, when $A \sim h$.

It turns out that the relaxation time possesses over a very wide range the property of being insensitive with respect to the size of the initial region A^n, tending, however, to infinity in the limit $A \rightarrow 0$, corresponding to a transition to the classical mechanics. From this insensitivity it can be concluded that with increase of the fluctuation the relaxation time increases very slowly, tending rapidly to the limit, corresponding to the minimum value of the region A^n (for $A \sim h$). In the case of an ideal gas, this limiting value of the relaxation time with respect to the velocities is given by the formula :

$$t = \frac{\frac{3}{2}\tau}{\ln \lambda/r_0} \left\{ \ln \frac{2\pi}{(\Delta p/p_0)} \right\},$$

where τ and λ are the duration and length of the mean free path, r_0 is the radius of a molecule, $p_0 = \sqrt{mkT}$, $\Delta p = A/L$, L is the linear dimensions of the system, and $A \sim h$; it thus proves to be of the order of a few τ. In a transition to the classical case, $A \rightarrow 0$ and $t \rightarrow \infty$. Under the condition $A \sim h$, the relaxation time can, however, depend on the choice of the initial region of this size. Since the space of 'initial regions', that is, of the results of the most complete experiments, is compact, it can be shown that the relaxation time for different initial regions of the same minimum size A^n possesses an upper boundary.

I wish to express my sincerest gratitude to Academician V. Fock for his participation in the discussion of certain above-mentioned questions.

N. KRYLOV.

[Received from Prof. J. Frenkel,
Academy of Sciences of the U.S.S.R.,
Moscow.
Oct. 10, 1943.]

[1] Hopf. *Ber. Ann. Wiss. Leipzig*, **3** (1932).

The Four-Colour Problem

THE correctness of the statement that any plane map may always be tinted with four colours in such a way that two areas meeting on the same boundary never have the same colour has always been admitted since Möbius mentioned it in 1840, although no mathematical proof of this theorem has yet been firmly established. I think I have found a rigorous and general proof of it. First, I have a theoretical proof of the common enunciation; secondly, I suggest a practical method of colouring. The complete paper is being submitted for publication elsewhere.

(1) Any plane map can be represented schematically as follows. Each area is figured by a point, and every contact between two contiguous areas is represented by a line connecting the figuring points. It is not difficult to show that any map, however complicated, can be reduced to a system of connected triangles externally limited by a unique triangle.

Then, using the method of general induction, I have shown that if it is always possible to colour a net of n vertices by means of four tints, the property remains true for a net of $n + 1$ vertices. In order to make this clear, I have used a theorem which is enunciated as follows : If a net R consisting entirely of triangles and of one—and one only—quadrilateral is colourable, then the net R^1 obtained by adding one supplementary diagonal in the quadrilateral is also colourable.

The evidence that a simple net consisting of a single triangle is colourable leads by induction to the complete demonstration.

(2) The foregoing statement is the basis on which the practical method of colouring rests.

A net already coloured with the four tints, 1, 2, 3, 4, might be coloured otherwise in black and white, making, for example, 1 and 2 white, and 3 and 4 black, in such a way that every polygonal black or white chain is open or when closed involves always an even number of vertices. The reciprocal proposition is true.

On the other hand, it is always possible to classify the vertices of any given net to be coloured in three groups, α, A, B, with two exceptional vertices, and to number the vertices: 1, 2, 3, . . . n, during the process of classification.

By definition, a vertex belonging to group α is directly connected with two and only two vertices, the number of either being lower than its own number. In the same way, a vertex A is connected with three, and a vertex B with four vertices. Nevertheless, it might happen that a vertex is connected with five preceding vertices, belonging then to a new type C. In this case, owing to a definite diagonal mutation of chosen sides of the net, such a vertex enters the group B.

All vertices being numbered and classified in types α, A, B, excepting the two vertices numbered 1 and 2, a general rule can be given for marking the vertices of the net in black and white in such way as to avoid any closed chain, black or white, involving an odd number of vertices.

After that the net can be coloured in the four tints 1, 2, 3, 4.

If any alteration has been made owing to eventual diagonal mutations, it is possible to return to the previous structure of the net, basing the necessary modifications of marking and colouring on the fundamental theorem enunciated in (1).

Bibliography. A short account of the history and bibliography is given in Rouse Ball's "Mathematical Recreations and Essays" (London: Macmillan and Co., Ltd., 1905, pp. 51–54), from which it appears that the problem was mentioned by Möbius in 1840 ; Francis Guthrie communicated it to De Morgan about 1850 ; although familiar to practical map-makers, Cayley redirected attention to it in 1878, but did not know of any rigorous proof of it ; in 1880 Tait published a solution (*Proc. Roy. Soc. Edinburgh*, **10**, 729 ; 1880) but it would seem to involve a fallacy (see J. Peterson, of Copenhagen : *L'Intermédiaire des Mathematiciens*, **5**, 225 ; 1898 ; **6**, 36 ; 1899).

S. M. DE BACKER.

Oakfield, Vine Road,
East Molesey, Surrey.
Feb. 1.

Distribution of Nucleic Acids

A QUESTION of great interest has been raised by Gulland, Barker and Jordan when they object to a nucleic acid terminology proposed by us[1]. We suggested that the terms 'chromonucleic' and 'plasmonucleic acid' be used as synonyms for 'desoxyribose' and 'ribose nucleic acid' respectively[2]. The latter terms are useful because they clearly denote an essential difference in *chemical* composition of the two known types of nucleic acid ; the former terms would be useful because they describe the striking *biological* distribution of the two nucleic acids.

In recent years it has been shown, contrary to what had been believed previously, that both types of nucleic acid are present in both plant and animal cells. There is indeed a profound difference in the distribution of the two types of nucleic acid; but the difference is discernible within each plant and animal cell. In all plant and animal cells on which careful observations have been made, one type of nucleic acid has been detected in the chromatin only, and we have accordingly suggested the name 'chromonucleic acid' for this type. The other type of nucleic acid, 'plasmonucleic', occurs in the cytoplasm, in the plasmosome (nucleolus) and possibly in minute quantities in the chromatin[3,4]. The distribution of the two nucleic acids provides a biochemical basis for the now classical cytological distinction between chromatin and other constituents of the cell. 'Chromonucleic' and 'plasmonucleic acid' are terms that epitomize the point of view of the cyto-geneticist, much as the term ascorbic acid does the point of view of another group of biologists—better than does the chemical term 2,3-enediol-*l*-gulono-1,4-lactone ! Gulland, Barker and Jordan object to the terms we have suggested because nucleic acids are present in viruses and bacteria as well as in cells with clearly defined nuclei. 'Chromonucleic' and 'plasmonucleic' are terms based on a distribution of the two acids within cells in which certain morphological features are visible. The presence of nucleic acids in viruses and bacteria is regarded by Gulland, Barker and Jordan as an "exception" to this distribution. This, in our opinion, is altogether too narrow a view to take, and it becomes apparent at once when we consider the presence of 'chromonucleic (desoxyribose) nucleic acid' in bacteria.

The existence of nuclei in bacteria has been a moot question for years. In the nuclei of many animal and plant cells, chromatin forms by far the bulk of the nuclear substance, and in some nuclei more than 90 per cent of the chromatin consists of desoxyribose nucleoprotein (chromonucleoprotein)[5]. The presence of desoxyribose nucleic acid in bacteria[6,7] and the preparation from bacteria of a desoxyribose nucleoprotein strikingly similar to those prepared from all nuclei[5] indicates that the chemical equivalent of chromatin is present in bacteria ; and whether or not this chromatin is organized in a morphologically distinct nucleus becomes, in a sense, a secondary matter. The discovery that a chromonucleoprotein, like that present in the nuclei and not in the cytoplasm of animal and plant cells, and forming the bulk of their chromatin, also exists in bacteria, is surely not so much an exception to the statement that such nucleoproteins exist in the nuclei of cells of higher animals and plants as an indication that bacteria contain chromatin.

It appears fruitful at present to compare the viruses with the self-duplicating bodies known to be present within the cells of plants and animals. Some viruses (vaccinia, bacteriophage) contain desoxyribose nucleic acid ; others (the tobacco mosaic virus, for example) contain ribose nucleic acid[3]. The suggestion arises at once that some viruses may be related to those self-duplicating bodies, the genes, that are so closely associated with the chromonucleoproteins (desoxyribose nucleoproteins) of chromatin and that other viruses may be related to self-duplicating bodies in the cytoplasm, such as the chloroplasts, which contain plasmonucleoproteins (ribose nucleoproteins).

The nucleic acid terminology which we have proposed does not ignore the presence of nucleic acids in bacteria and viruses ; on the contrary, this terminology implies that the distribution of nucleic acids has a profound biological significance.

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Carbonic Anhydrase

IN a recent letter in NATURE[1], Keilin and Mann question the zinc content of carbonic anhydrase reported by us. The facts seem to be that they have obtained an enzyme preparation (which they believe is highly purified) having a zinc content of 0·3–0·33 per cent[2], and we have obtained a preparation (which we likewise feel we have shown to be highly purified) having a zinc content of 0·2–0·23 per cent[3]. Realizing that criticism can be directed against the determination of any low zinc content, whether the method used be the dithizone method employed by Keilin and Mann or the method of Sahyun and Feldkamp used by us, we conducted preliminary experiments and reported[4] that "Before zinc estimations were conducted on the enzyme, analyses were made on a sample of zinc-insulin crystals with the same technique as was used in estimating the zinc in the enzyme. Duplicate results agree within 4 per cent. Moreover, these results were in good agreement with the metal content of the crystals as calculated from ash determinations. Along with each estimation of the zinc content of an unknown sample it was routine procedure to determine likewise the zinc content of a standard zinc solution". In all our estimations of the zinc content of the enzyme preparations, care was taken that a reasonable quantity of material was used. Recently Prof. Thode of McMaster University made polarographic determinations of the zinc content of our enzyme preparation and found it to be 0·22 per cent. We feel that the comparatively low zinc values reported by us are not attributable to the method of determination used in our work.

Keilin and Mann direct attention to the fact that the carbonic anhydrase content of ox blood as determined in our laboratory[5] was approximately twice that reported by them for washed ox red blood

corpuscles[2]. In view of the fact that "in any one species there is a two- to four-fold variation or more"[6] in the enzyme content of blood, it could be expected that there might be a difference in the enzyme values reported from the two laboratories. However, the primary object of our communication[5] was to direct attention to the marked instability of dilute solutions of highly purified preparations of the enzyme. This instability is so great that we believe it is impossible to determine accurately the potency of dilute aqueous solutions of the enzyme by the unmodified glass boat method used by Keilin and Mann. Our work showed that the addition of a very small amount of peptone or of certain other substances (themselves free from enzyme activity) rendered solutions of carbonic anhydrase stable and made assay possible. Such stabilized solutions of the purified enzyme had activity double that obtained for similar aqueous solutions of the enzyme when attempts were made to assay these immediately after the solutions were prepared for assay. It would be a matter of interest to determine the potency of the highly active preparation of Keilin and Mann in the presence of a small amount of peptone, to ascertain whether under these stable conditions their preparation would indicate an activity as great as that which we have reported.

Keilin and Mann state that the crystalline compounds of carbonic anhydrase with piperidine, *iso*-amylamine and *n*-amylamine described by us have "no relationship to the enzyme". Evidently they have not understood our use of these compounds. Of course these *dried* crystalline preparations are "devoid of catalytic activity", as are the dried crystalline preparations of the enzyme obtained from ammoniacal acetone and as are dried crystalline preparations of certain other enzymes. In the case of the hormone insulin, the crystalline base-insulin preparation *retains* activity after drying[3,7] even though the potency of insulin is ordinarily readily destroyed in the presence of a base. Since a substance so labile as insulin retains potency under these conditions, it seems that an explanation other than alkalinity must be found for loss in potency during drying of a crystalline preparation of a substance so remarkably stable to base (*p*H 12) as is carbonic anhydrase[6]. If consideration is given to the drying of the crystals, it seems not unlikely that water may be concerned. This is further suggested by the marked instability of the enzyme in dilute aqueous solutions, and by the fact that crystalline preparations of the enzyme obtained from ammoniacal acetone are inactive after drying.

Keilin and Mann also object to the use of these liquid bases because they form crystalline compounds with other proteins. As a matter of fact, there are few chemicals which are specific for the crystallization of only one protein. It was a matter of much interest to us to learn that Keilin and Mann had often observed thin plates during precipitation of the purified enzyme.

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Antibacterial Action of Arsenic

Voegtlin[1] and Eagle[2] have produced convincing, even if partly circumstantial, evidence that organic arsenicals act on trypanosomes and spirochætes by combining with –SH (thiol) groups in enzyme systems essential for the metabolism of these organisms. These workers showed that arsenobenzenes act in this way only after oxidation to the corresponding arsenoxides, and likewise pentavalent arsenicals become active only after reduction to their arsenoxides.

More recently, Fildes[3] has produced evidence that mercurial antiseptics acted on bacteria by combining with –SH groups in enzymes essential for bacterial metabolism. Accordingly one of us (J. E. F.) pointed out[4] that arsenoxides should act as antiseptics towards a wide range of bacteria, as mercurials do. Should arsenoxides prove ineffective against a variety of bacteria *in vitro*, a vital inconsistency between the Voegtlin theory of the action of arsenicals on trypanosomes and spirochætes and the Fildes theory of the action of mercurials as antiseptics would be revealed.

Curiously enough, no reference earlier than 1942 to the successful action of arsenicals in significant dilution against common pathogenic bacteria (that is, other than the atypical spirochætes and bartonellæ) could be found. Hirsch[5] showed that atoxyl (*p*-aminophenylarsonic acid) has a sulphonamide-like action on *B. coli*. But here it is not acting as an arsenical but through its structural resemblance to *p*-aminobenzoic acid. Indeed Peters[6] has shown that other pentavalent arsenicals not having this resemblance, such as acetarsol (*p*-hydroxy-*m*-acetylaminophenylarsonic acid) and tryparsamide (N-phenylglycineamide-*p*-arsonic acid), are inactive towards this organism. Peters noted, however, that *m*-amino-*p*-hydroxyphenyl-arsenoxide was highly active against *B. coli* and was not antagonized by *p*-aminobenzoic acid. Osgood[7] had shown that neoarsphenamine (an arsenobenzene) was effective against *Streptococcus viridans* in bone-marrow culture if left for 2–3 days, but believed that the mechanism was different in this case from that obtaining with trypanosomes.

To assist the clarification of this rather confused picture, we have submitted arsenical drugs typical of each of the three possible levels of oxidation to a bacteriostatic analysis. The technique followed has been previously described[8], and the same pathogenic strains were used as heretofore. The medium used has been found to contain enough *p*-aminobenzoic acid completely to counter any sulphanilamide-like drug activity. The arsenoxide was used in the form of 'Mapharsen N.N.R.' (synonyms: 'Mapharside', 'Neohalarsine', arsphenoxide), due allowance being made for the diluent present. The acetarsol was dissolved in an equivalent of sodium hydroxide, the proflavine in an equivalent of hydrochloric acid and the other substances in water. The results are given in the accompanying table.

Discussion. The table demonstrates that arsenoxide behaves towards a wide range of bacteria as a potent antibacterial of the same order of activity as the acridines and the mercurials, and it is as easily inactivated by a typical thiol compound as mercurials are. The pentavalent arsenical (acetarsol) was quite inactive and the arsenobenzene (neoarsphenamine), which was tested under hydrogen to secure conditions unfavourable to its oxidation, showed only slight and limited activity.

It is concluded that at least one organic arsenical

Highest dilutions completely inhibiting growth in 48 hours at 37° C. (Medium: peptone-broth containing 10 per cent serum; *p*H 7·2.)

Substance	*Cl welchii*	*Strept. haem* A.	*Staph aureus*	*B coli*	*Proteus vulgaris*
Arsenoxide (*m*-amino-*p*-hydroxyphenylarsenoxide)	1.160,000	1: 80,000	1·160,000	1.10,000	1:10,000
Acetarsol B.P. (*m*-acetylamino-*p*-hydroxyphenyl-arsonic acid)	*	*	*	*	*
Neoarsphenamine B.P (N-methylenesulphoxylate of *m*-amino-*p*-hydroxy-arsenobenzene	1 10,000	1: 10,000	1: 10,000	*	*
Arsenoxide in 0·1 per cent thioglycollate broth	1 5,000	1· 10,000	*	*	*
Proflavine (2 : 8-diaminoacridine)	1·320,000	1·160,000	1: 20,000	1:20,000	1·10,000
Mercuric chloride	1. 40,000	1.160,000	1: 40,000	1:80,000	1:80,000

* Signifies not inhibitory at 1 : 5,000.

at the arsenoxide level of oxidation is a potent antibacterial acting after the fashion of the mercurials, whereas closely related arsenicals at both higher and lower levels of oxidation are inactive. Hence the Voegtlin and the Fildes hypotheses are more closely linked than heretofore. This hitherto unsuspected antistaphylococcal action of arsenoxide is, in our experience, inferior only to that of penicillin, ethyl mercurithiosalicylate ('Merthiolate') and crystal violet. In view of the widespread experience of the use of this drug in syphilis, it should not be a difficult matter to determine whether it is clinically useful in staphylococcal infections.

We wish to thank Miss J. Stone for valuable assistance in performing these tests.

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Cataphoretic Velocities of Pure Copper Ferrocyanide Sol

The cataphoretic velocities of the sols formed from the precipitates from potassium ferrocyanide and copper sulphate solutions peptized with water after washing by centrifugalization were measured by the microcataphoretic method[1].

In the pure sol of copper ferrocyanide, the cataphoretic velocities of particles of different sizes vary from $-16 \cdot 5 \times 10^{-5}$ to $-56 \cdot 8 \times 10^{-5}$ cm. per sec. per volt/cm. It is found that the larger particles move with a higher velocity and smaller particles with a lower velocity. Therefore the velocity we actually get after calculation is the average of all the velocities of all the particles.

The cataphoretic velocities of centrifuged sols are less than those of the non-centrifuged sols[2]. The cataphoretic velocities of a sol increase with time. If the non-centrifuged sol be kept for a month and then centrifuged, it is found that the centrifuged sol has a higher velocity than the non-centrifuged sol.

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A Method for Collecting Sporozoites of *Plasmodium gallinaceum* by Feeding Infected *Aedes aegypti* through Animal Membranes

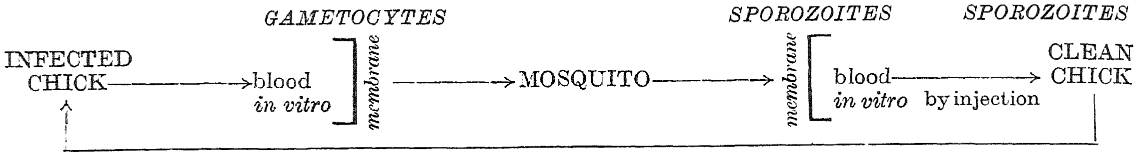
The well-known difference between the resistance of blood-inoculated and mosquito-induced malaria indicates that sporozoites, or the stages arising immediately from them, are very resistant to the action of the known anti-malarial drugs. Since a true prophylactic drug, that is, one which will prevent sporozoite-induced infections, is the most urgent requirement in the chemotherapy of malaria, a method for testing drugs directly on sporozoites is of great importance. Hitherto the only method of doing this was to obtain sporozoites by the dissection of salivary glands from infected mosquitoes, which is both laborious and unsatisfactory, as the sporozoites are always mixed with and may be protected by fragments of the salivary gland cells. Thus it is difficult to obtain them in uniform suspension and to be sure that they are all exposed equally to the action of the admixed drugs being tested.

In order to overcome these difficulties, we began to work upon the possibility of obtaining sporozoites free from gland tissue by feeding infected mosquitoes (*Aedes œgypti*) through animal membranes. Gordon[1] had shown that mosquitoes would feed through a fresh animal membrane, and Yoeli[2] had infected *Anopheles elutus* with *Plasmodium falciparum* by inducing the mosquitoes to gorge upon infected blood through a prepared rabbit-skin membrane.

The type of membrane which we have found to be the most successful is one made of chicken skin. We prepared it by soaking the skin of a 1–3 week old chick in absolute alcohol for at least 30 minutes, washing it in running tap water and stretching it over a piece of glass tubing 2·5 cm. × 6 cm., and keeping it in place, until dry, by a thin rubber band. On drying, the skin is thin and parchment-like and adheres firmly round the glass tubing, making a water-tight seal.

The highest rates of gorging are obtained when the blood in the membrane (1·5–3 c.c. of heparinized chick blood) is warmed to 41–42° C. and kept warm by a surrounding water-jacket filled with water at that temperature. Moistening the outer side of the membrane, that is, that presented to the mosquitoes, with saliva also increases the rate of gorging as compared with a dry surface. The apparatus is placed upon the mosquito-netted top of a jar containing *Aedes œgypti* so that the surface of the membrane rests upon the netting. Gorging is effected in the dark in an incubator at 28° C., in a moist atmosphere.

We have infected *Aedes œgypti* with *Plasmodium gallinaceum* by feeding mosquitoes through a mem-



INFECTIVE CYCLE OF *Plasmodium gallinaceum*, BY *Aedes ægypti*, THROUGH ANIMAL MEMBRANES.

brane upon heparinized chick blood heavily infected with gametocytes. The rate and intensity of infection, as assessed by oocyst counts on the fourth day, were equal to those obtained from mosquitoes of the same age-group gorged on the same chicken immediately prior to drawing the blood for the membrane experiment.

What is, however, more important for our work, is that we have been able to demonstrate that infected mosquitoes, when they gorge through a membrane, extrude sporozoites into the blood, and that these sporozoites are viable, since the blood containing them when injected into clean young chicks produces infections typical of mosquito transmission.

Mosquitoes, which became infected as a result of gorging through a membrane upon blood containing gametocytes of *P. gallinaceum*, have ejected sporozoites through a membrane into uninfected chick blood, and this blood has proved infective when injected into a clean chick. The cycle of development as shown in the accompanying chart has, therefore, been completed.

In obtaining sporozoites from infected *Aedes ægypti* only batches of mosquitoes which have been proved, by oocyst count on the fourth–fifth day, to be heavily infected are used. The rate of gorging through a membrane of infected mosquitoes (that is, mosquitoes which had already had one, the infective, blood-meal) is generally not so high as when mosquitoes gorge for the first time, but usually at least 50 per cent gorge, and in certain batches the rate has been as high as 90 per cent.

Our practice is to allow the mosquitoes thirty minutes in which to gorge upon 1·5–3 c.c. of heparinized blood from clean chicks, and then to pipette out the blood from the membrane and shake it well to ensure that the sporozoites are evenly distributed. The blood (0·4–0·5 c.c. per bird) is injected intravenously into 5–10 day old chicks. Groups of three or four chicks injected with blood from membranes through which batches of 35–53 mosquitoes had gorged showed parasites in their peripheral blood on the sixth–seventh day. This incubation period is, in our experience, similar to that in chicks bitten by two to four heavily infected mosquitoes. In one experiment, blood from which forty-five mosquitoes had gorged produced infections of such intensity in six chicks that five died on the seventh day, post-mortem examination revealing enormous numbers of exoerythrocytic schizonts in the capillaries of the brain.

Infected Aedes remain infective after gorging through a membrane and can be induced to eject their sporozoites by this method on more than one occasion. Thus a batch of thirty-nine infected mosquitoes ejected sporozoites through a membrane into clean blood on the ninth day after infection. From this blood five chicks were infected. Six days later, the twenty-one Aedes surviving gorged again through a membrane upon clean blood, and the blood in the membrane proved infective to the two chicks inoculated with it, parasites being found in the peripheral blood of each chick on the sixth day.

Experiments are now being made upon the applicability of this method for testing the action of anti-malarial drugs directly upon sporozoites and the developmental stages arising from them, and the results will be reported later.

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Action of Inert Dusts on Insects

IN his recent letter Dr. Wigglesworth[1] has explained the desiccating action of inert dusts on insects by the abrasion and perhaps adsorption of waxy substances forming a thin layer on the cuticle. The following results, which appear to confirm his conclusions, were obtained while comparing the dust resistances of various races and species of Drosophila, and spraying dust on some other animals. Of the various dusts tested, the loss of water was most accelerated by shaking the insects with charcoal of plant or animal origin. At 25° C. and 40–50 per cent relative humidity, *Drosophila melanogaster* flies were dead after eleven minutes, and *D. subobscura* after nine minutes, whereas in an atmosphere saturated with moisture, they survived for many hours. Mosquitoes, house-flies and house-spiders dusted with charcoal and kept in a centrally heated room died in less than an hour, and a young newt died in about two hours. Earthworms and slugs, on the other hand, were not killed by the dusts.

Pupæ of *D. melanogaster* did not die in charcoal, but the flies emerging from them soon did; larvæ survived for several hours. Drosophila flies which were narcotized in carbon dioxide, shaken and kept with charcoal in an atmosphere sufficiently rich in carbon dioxide to keep them immobilized, survived in this condition for several hours, and died only ten minutes after they had recovered in air and had been running. Similarly, at 5° C. and about 70 per cent relative humidity, Drosophila flies survived in charcoal for several hours. If immobilized by carbon dioxide or chill after they had been crawling in charcoal for two to three minutes, Drosophila flies dried up and did not recover.

The dependence of the desiccating effect on movement was also evident in the first instars of Dixippus. Cataleptic individuals survived much longer when dusted with charcoal than did active animals. In the cottonstainer Dysdercus sp., the abrasive effect of charcoal could be observed directly under the binocular microscope without using a dye. If a later instar of this bug was dusted with charcoal and turned on its back, white scratches, looking as if paraffin

wax were scratched with a needle, could be observed on the cuticle of the abdomen where the femora had rubbed it. If the legs were cut before dusting, no scratching could of course occur, and the nymph survived much longer.

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A System of Notation for Petroleum Hydrocarbons

I SHOULD like to invite attention to a system of notation I am using for petroleum hydrocarbons. In recent years the tendency to invent trade names (such as 'triptane' for 2,2,3-trimethyl butane) is understandable, but is to be deplored as a retrograde step away from unification and systematization. There is no need to depart from the international system of nomenclature if some simple system of notation is used for groups of atoms. The accompanying table contains a list which I have found suitable. It applies generally to hydrocarbons boiling in the gasoline range and a few simple substituted derivatives.

NOTATION FOR THE SYSTEMATIC NAMES OF HYDROCARBONS.

Abbreviation	Group or meaning	Abbreviation	Group or meaning
M	methyl	X	xylenes
E	ethyl	i	*iso-*
P	propyl	s	secondary
Ph	phenyl	t	tertiary
b	butyl	c	cyclo
a	amyl	Δ	double bonds (positions indicated by following figures)
4	butane		
5	pentane		
6	hexane	δ	triple bonds (positions indicated by following figures)
7	heptane		
8	octane		
9	nonane		
10	decane	Substituents	
B	benzene	F	fluoro
T	toluene	C	chloro
oX	*o*-xylene	Br	bromo
mX	*m*-xylene	I	iodo
pX	*p*-xylene	N	nitro
		A	amino

Only the necessary minimum number of symbols is used, as there is no need to include the total number of alkyl groups in the name. For example, 2,2,3-trimethylpentane becomes 223M5; *iso*-octane is written i8, and 2,2,4-trimethylpentane becomes 224M5. *Iso*-pentane can be written i5, though the purist would prefer 22M3. In the naphthene series *cyclo*pentane becomes c5, and 1-methyl-3-*iso*propyl *cyclo*hexane becomes 1M3iPc6. Among the aromatic hydrocarbons we have EB for ethyl benzene and 135MB for mesitylene. The olefine butadiene becomes 4Δ13 and 2-methyl-3-ethyl pentadiene Δ2–4 becomes 2M3E5Δ24. Acetylene is 2δ. I have no experience of using this notation for the substituted hydrocarbons, and the extension to the list is offered without experience to stimulate criticism or extension of the notation.

Similar notations are probably in use in other laboratories, but in these days when the detailed analysis of fuels is occupying so many chemists on both sides of the Atlantic, a simple, uniform notation for the international nomenclature for labelling samples and for use on graph or in tables would be of considerable value, particularly as so much of this information has to be exchanged.

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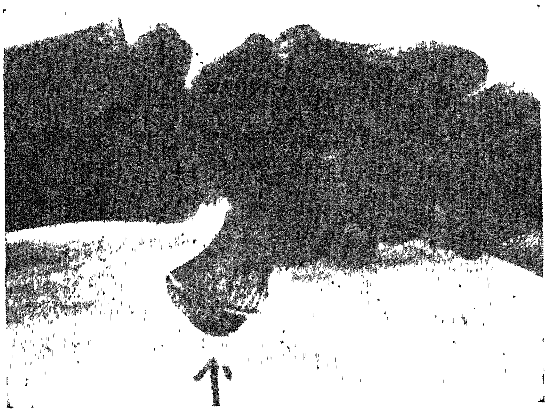
The Pisiform Bone

THE pisiform bone is often dismissed by the human anatomist as an insignificant sesamoid bone in the tendon of the flexor carpi ulnaris muscle. notwithstanding its articulation with the os triquetrum (os ulnare of comparative anatomy).

An extensive analysis of radiographs of the carpus in various mammals has shown that this minisculum is a canonical carpal bone, for in all young primates examined, with the exception of man, it presents a secondary bony centre with a well-marked epiphysial growth cartilage. The bony epiphysis is clearly shown in the accompanying lateral radiograph of the wrist of a young *Macacus rhesus*.



LATERAL RADIOGRAPH OF THE WRIST OF A YOUNG *Macacus rhesus*. (× 3.) THE ARROW POINTS TO THE BONY EPIPHYSIS OF THE PISIFORM BONE.

The pisiform is now, for the first time, shown to be analogous to the os calcis, which alone among the bones of the tarsus has a secondary centre of ossification in all primates, including man.

The hitherto unsuspected existence of this epiphysis in the pisiform bone makes it necessary to revise for all vertebrate forms the present views on the morphology of the carpus and tarsus. No mention of the epiphysis is found in the book on the hand by Wood Jones[1], in the anatomy of the rhesus monkey by Hartman and Straus[2], or in the extensive monographs by Schreiber[3] and Schwartz[4]. The same is true of the various papers by Broom and Watson on fossil forms.

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Geostatics

RECENTLY, at King's College, Newcastle upon Tyne, more than seventy engineers and architects studied the subject of 'soil mechanics'. A week of lectures and drawing office practice under the direction of Mr. A. W. Skempton, of the Building Research Station, resulted in considerable discussion of the various aspects of the problems involved. In such discussions, the name given to this rapidly developing science was the subject of criticism on the following lines:

(1) The word 'soil' has, for centuries, signified that extreme upper layer of the earth's crust which can support plant life. In 'soil mechanics' the word is forced out of its usual connotation to include any of the unconsolidated or partially consolidated geological sediments existing to any depth likely to be of interest to the engineer or architect.

(2) Even if the meaning of 'soil' be extended to include sands, gravels, silts, and clays of any depth, it cannot, logically, be applied to harder materials such as shales, to which the methods of 'soil mechanics' do apply.

(3) The term 'mechanics' is misleading and covers a field which is too wide to identify the specialized statical problems involved. The methods of 'soil mechanics' are not, for example, extended to include dynamical problems.

(4) The term 'soil mechanics' is clumsy, and not self-explanatory.

'Soil mechanics' is the science of applying the methods of statics to data deduced from the measured properties of geological sediments. The results obtained indicate the static forces involved in earthworks or in foundation design. For this reason, and since there is no collective term to indicate the loose sediments of the earth's crust, we suggest that the term 'Geostatics' should be employed. This suggestion forms a constructive reply to the well-founded criticisms of the present name, and covers adequately and neatly all possible aspects of 'soil mechanics'.

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May 15.

Wordsworth and Science

THE important question is surely not whether Wordsworth should now and again have scoffed at men of science with or without provocation, but whether the poems as a whole suggest that he felt at heart that it were incumbent upon poets to give recognition to scientific knowledge. Now I submit and, indeed, tried to show in an article published in NATURE of November 28, 1942, that the very strength of Wordsworth's unique Nature mysticism depends on the tacit acceptance of science in principle discernible in the poems. This must be precisely why the forerunners of this journal so wisely selected a now time-honoured Wordsworthian motto, and why ever to discard it would be a most foolish blunder.

I should like to quote a few lines from "The Excursion" as exemplifying with peculiarly solemn power the depth of this great poet's philosophical outlook upon Nature:

"He, many an evening, to his distant home
In solitude returning, saw the hills
Grow larger in the darkness; all alone
Beheld the stars come out above his head,
And travelled through the wood, with no one near
To whom he might confess the things he saw."

That lad returning from school over the wild Perthshire hills shows himself a "visionary of the first water"—of the finest calibre with the making both of a man of science and a poet; for he is seeking to peer behind the natural scene and to capture a hidden meaning in the grand and impressive phenomena of the landscape. Here we certainly have flights of poetical imagination properly disciplined by scientific caution and faith in the "solid ground of nature". Such great moments as were vouchsafed to the Wanderer will repeatedly and often unexpectedly come to everybody who cultivates the requisite outlook.

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Patent Law and Procedure in Austria

IN view of the present interest in the reform of the patent law and procedure in Great Britain (see NATURE, May 6, p. 553), it may be worth while to refer briefly to the manner in which the Austrian Patent Act, 1925, has tried to cope with one of the most intricate problems concerned, namely, the treatment of the scientific worker in his quality as inventor. Under this Act—which seems to be the most progressive legislation in this field of law—the employee is considered the owner of his inventions, even if they had been made in the course of his employment. He may assign his invention and the patent applied or granted therefor to his employer or may grant him a licence, and is bound to do so if agreed upon in either an individual or collective agreement; but he is entitled to claim an adequate compensation for such assignment or grant of licence, a right which he cannot validly waive in advance. Failing an agreement between employer and employee, the Court has to assess the compensation, taking into consideration the importance of the invention, the possibilities of utilizing the same and the part which facilities provided by the employer and his experience have played in arriving at the invention. Such a decision may be altered by the Court on application of either side if circumstances have essentially changed.

Experience has shown in Austria that the question of compensation has nearly always been solved by agreement, so that resort to the Court was necessary only in very few exceptional cases.

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Petrological Microscopes

A SMALL committee has been formed, including representatives of the Mineralogical and Geological Societies, with the object of furthering the manufacture of petrological microscopes in Great Britain. The committee would welcome comments from any persons interested with whom they are not already in touch, to be addressed to the Secretary, Petrological Microscope Committee, Geological Survey Office, Exhibition Road, S.W.7.

A. BROUGHTON EDGE.
A. F. HALLIMOND.
(Acting Secretaries.)

RESEARCH ITEMS

Putrescine in the Biosynthesis of Hyoscyamine

IN plants of *Atropa belladonna* and *Datura stramonium*, growing normally, hyoscyamine appears to be formed principally in the root, with putrescine as an intermediate metabolite, and then moves upwards through the vessels into the stem, leaves, fruit and seeds (B. T. Cromwell, *Biochem. J.*, **37**, 717 and 722; 1943). The author's previous work on the biosynthesis of berberine and hyoscyamine had led to the conclusion that these alkaloids are synthesized from products of carbohydrate and protein breakdown. Work on the nature of the intermediate reactions leading to the formation of hyoscyamine, by experiments on exudates of cut stems, grafting and slow injections of various substances into stem stumps or branches of *Atropa belladonna* and *Datura stramonium*, showed the root as the probable locus of synthesis, and demonstrated the stimulating effect of arginine, hexamine, formamol and especially putrescine. This is compared with results of other workers (for example, Dawson. *Science*, **94**, 396; 1941), who concluded that nicotine is synthesized mainly in the root of the tobacco plant and that the alkaloid moves from the root system via the xylem to the leaves. It was of interest to determine the manner in which putrescine provided its contribution to the hyoscyamine molecule. Bearing in mind the use of succinaldehyde in the synthesis of tropinone, it might be concluded that putrescine gives rise to succinaldehyde by oxidation. The occurrence of an enzyme system bringing about the oxidative deamination of putrescine with formation of ammonia and an aldehyde in roots and etiolated shoots, and the isolation of small amounts of putrescine from leaves and upper stems of *Atropa belladonna* and *Datura stramonium*, add weight to these considerations.

Biology of the Albacore

VERNON E. BROCK has discussed ("Contribution to the Biology of the Albacore (*Germo alalunga*) of the Oregon Coast and other Parts of the North Pacific". *Stanford Ichthyological Bulletin*, 2, No. 6; Dec. 1943. Contrib. No. 10, Department of Research, Fish. Commission of Oregon) the albacore fishery in connexion with the probable causes of the sudden reduction in abundance off the coasts of California. This is the result of the first four years study and describes certain biological features in the albacore populations of the Pacific coast with emphasis on those of Oregon, and presents a review of all available material on the species from other parts of the North Pacific in so far as the material bears on the fishery problems. Fish with ripening ova are not present in the Oregon fishery and have never been recorded from the Californian fishery. It is probable that those forming the fishery have never spawned. The available evidence strongly suggests that only a few year-classes are present in the temperate-water fisheries for this species and that these are immature. This may, at least in part, account for the history of instability shown by the Californian fishery and may cause a similar instability in the Oregon fishery. The populations exploited by the North Pacific albacore fisheries may represent three different stocks or races which centre off the coasts of North America, Hawaii and Japan. The existence of albacore in mid-Pacific at positions roughly midway between these localities makes it appear possible that a certain amount of mingling may occur. It is not known if those fish occurring offshore represent wholesale migratory movements, but if so, the study and conservation of this species would cover the entire North Pacific Basin.

Mutations in Bacteria

THE nature of variation in bacteria is a theme upon which disagreement exists. G. Luria and M. Delbruck (*Genetics*, 28, 491; 1943) have discovered some important facts regarding this problem. *Escherichia coli* B. in culture with bacterial virus 9 first shows complete lysis and then, after a few hours, secondary cultures make their appearance. These consist of cells which breed true to resistance to attack by the virus. The distribution of resistant bacteria in the various cultures of sensitive bacteria was ascertained. The fluctuation in the number of resistant bacteria was considerably higher than could be accounted for by sampling error. On the theory that the resistance is due to acquired immunity, there will either be a binomial distribution or a Poisson series if the numbers are small. On the mutation theory the assumption is that there is a fixed chance of change per unit time, which is measured in cycles of bacterial division. The authors show that a variance much greater than unity is to be expected. In every case, the experimental results accord with the calculations on this theory, with a discrepancy of even higher variability than expected. The mutation-rate was determined experimentally to be $2{\cdot}45 \times 10^{-8}$ per bacterium per division cycle.

New Species of Aquatic Fungi

Two papers recently published by C. F. Ingold (*Trans. Brit. Mycol. Soc.*, 26, Pts. 3 and 4, 104 and 148; Dec. 1943) describe four new species of aquatic Hyphomycetes. *Dendrospora erecta* and *Piricularia anomalum* were found on decaying submerged oak leaves. The former species necessitated also the creation of the new genus Dendrospora, the main criterion of which is the production of tree-like spores, as the name implies. *Tricladium anomalum* was found growing on decaying submerged leaves of *Typha latifolia*, while *Triscelophorus monosporus* inhabited leaves at a later stage of decay, too rotted for identification. Triscelophorus is also a new genus. It seems possible that aquatic Hyphomycetes are of fairly wide distribution. Dr. Ingold has recorded several species upon decaying sweet chestnut and hawthorn leaves in addition to oak and alder leaves as described in an earlier paper.

Continental Drift and Fossil Floras

IN a study entitled "Continental Drift and Plant Distribution" (privately printed, 1943), Prof. D. H. Campbell, of Stanford University, California, argues that, from a comparison of the existing and fossil floras of the northern and southern hemispheres, it is clear that the two areas were completely separated up to the end of the Mesozoic period, and that North America and Eurasia have always been more or less intimately connected. The relations between the genera and even species of New Zealand and Chile, and West Africa and Brazil, are so close that former land connexions must be assumed. Most of the common forms could not have been transported by ocean or air currents. The almost complete absence from the southern continent of the characteristic

boreal trees, such as Pinaceæ, Fagaceæ, Salicaceæ, Magnoliaceæ and others, and the absence in the northern hemisphere of many austral families, like the Myrtaceæ and Proteaceæ and the coniferous Araucaria and Podocarpus, is evidence of the complete separation of boreal and austral land masses from late Palæozoic to late Mesozoic times, and confirms Du Toit's theory of two original land masses of Laurasia and Gondwana rather than Wegener's theory of Pangæa. When the first connexions between the two were established is not certain. The paper contains a great deal of closely reasoned evidence.

Meteorites and an Earth-Model

UNDER this title R. A. Daly discusses the old hypothesis that the materials of the substratum and core of the earth are likely to be closely similar to those of average meteorites (*Bull. Geol. Soc. Amer.*, **54**, 401; 1943). The paper summarizes the principal observed facts about the nature of meteoritic stones and irons, and the reasons for supposing them to be fragments of a disrupted parental planet. After comparison between the latter and the earth itself, the hypothetical evolution of the earth is tested by reference to the terrestrial discontinuities revealed by seismic evidence, and to mean density, moment of inertia, radioactivity and plasticity. Rough estimates of the temperatures and the degrees of strength of the materials in depth are deduced. The author assumes the earth to have been initially gaseous with a temperature well above the boiling point of iron (about 3,000° C.) and traces the probable effects of condensation and differentiation. The suggested course of development leads to an earth-model which has the following succession from surface to centre: a crust or lithosphere; a thicker vitreous asthenospheric (weak) shell; a still thicker crystallized mesospheric shell; and a nickel-iron core, probably fluid and possibly behaving much like a gas. It is frankly confessed that the processes envisaged fail to account satisfactorily for the existence of a sharply defined radioactive layer. Moreover, no attempt is made to apply tests of a dynamical character, that is, to confront the model with the geological facts of mountain-building and vulcanism. Nevertheless, quite apart from its conclusions, some of which are necessarily highly speculative, the paper is extremely valuable as a compendium of all the relevant data by which such speculations must be guided.

Reaction Kinetics in Solution

IN the Tilden Lecture to the Chemical Society (*J. Chem. Soc.*, 629; 1943) R. P. Bell gave an account of some attempts to calculate velocity coefficients on the basis of activation energy. The fundamental equation was proposed by Arrhenius, and for bimolecular reactions is $k = Ae^{-E/RT}$, where E is the activation energy, having values from 7 to 40 k.cal. per mol. The values of A vary considerably ($10^2 - 10^{19}$) and, although the values are distributed over the whole range, smaller values apply to reactions between uncharged molecules and larger values to reactions between ions. The A values have been interpreted either as giving the product of the collision frequency Z and a so-called probability factor P, namely, $A = ZP$, and also on what is called a transition state theory, in which the equilibrium constant K for a state X through which the reacting molecules pass during reaction ($A + B \rightleftharpoons X$) and the thermal velocity v, which does not vary greatly from one reaction to another, are connected by the equation $k = Kv$. It appears that in solution Z is not greater than four times its value for the reaction in the gaseous state. The question of solvation is an important one, and is dealt with rather fully in the lecture. In a series of solvents A and E are found to change in a parallel manner. The lecture gives a concise yet comprehensive survey of the subject with which it deals.

Boundary Lubrication and Heat of Absorption

FOLLOWING an earlier investigation of the effect of temperature on the boundary lubrication of mild steel surfaces by a number of pure long-chain compounds, J. J. Frewing has now published a study correlating the results with heat of absorption (*Proc. Roy. Soc.*, A, **182**, 270; 1944). The frictional behaviour between mild steel surfaces lubricated with solutions in white oil of long-chain halides and other compounds was studied under high loads at low speeds. For all compounds a transition from smooth sliding to stick-slips occurs at a temperature characteristic of the particular solution used. The transition temperature increases with the concentration. Each solution builds up, and is in equilibrium with, an absorbed and oriented film of the polar compound on the surface. By assuming that the transition occurs when the surface concentration of this film decreases to a certain value which, for any one material, is independent of temperature, an equation was deduced relating the concentration and transition temperature with the heat of absorption (U). The equation fits the experimental results well. From the values of U it appears that these long-chain polar compounds are adsorbed by the interaction of their dipoles with the atoms in the metal surface and not by any chemical reaction. The results also suggest that the esters are similarly oriented at metal and at aqueous surfaces.

Polarization in Fraunhofer Lines at the Sun's Limb

DR. ZANSTRA showed in 1941 that if atoms in the solar atmosphere acted like classical oscillators, light within Fraunhofer lines should be polarized near the sun's limb (*Mon. Not. Roy. Astro. Soc.*, **101**; 1941). R. O. Redman examined the solar spectrum at $\sin\theta = 0{\cdot}985$, and was able to obtain only a small amount of polarization in the line 4227, Ca I, the observed effect being only about one tenth of that predicted by theory. Zanstra showed later that collision damping would reduce the predicted polarization very considerably, and Redman has suggested recently that the polarization would be weakened by the roughness of the sun's surface (*Mon. Not. Roy. Astro. Soc.*, **103**, 173; 1943). Fresh observations have now been made by Redman at the Radcliffe Observatory, using an improved method (*Mon. Not. Roy. Astro. Soc.*, **103**, 6; 1943). A description of the apparatus is given. By suitable arrangements the observations are much more accurate than those previously obtained. In addition to certain precautions, check photographs were made at the centre of the sun's disk, where there should be no polarization, these being taken immediately after the limb photographs. The results confirm the previous conclusion that polarization in the Fraunhofer lines is much smaller than was predicted by Zanstra's original theory.

PHOTOGRAPHY IN AGRICULTURAL RESEARCH

ON April 29, the Association for Scientific Photography held a meeting at Caxton Hall, London, to discuss "Photography as a Tool in Agricultural Research". Papers were read by Dr. E. M. Crook and Mr. V. Stansfield, of Rothamsted Experimental Station, and by Mr. J. C. Hawkins and Mr. R. H. Broome, of the National Institute of Agricultural Engineering, Askham Bryan, and illustrated by lantern slides and cine films.

The word 'tool' was included in the title in order to emphasize the fact that the centre of interest should be no radically new departure in the use of photographic materials in agricultural research, but simply the day-to-day use of well-known and well-tested techniques such as can be depended upon to yield results with a minimum of trouble and incidental research.

A large proportion of the photographic work of both institutes, as indeed is true of all photography applied to science, arises as a result of the need for an adequate means of preserving a detailed and easily comprehended record of very complex situations and phenomena. A single photograph will often record experimental results more adequately than several pages of written notes; in addition, it often preserves for future reference effects which were quite unnoticed at the time the experiment was made. Similar considerations apply to the use of photographs for passing on instructions for assembling or adjusting an agricultural implement or recognizing a certain plant disease. The photographic record, being objective, is also a valuable means of establishing beyond dispute the results of tests such as the Institute of Agricultural Engineering continually carries out on articles submitted by manufacturers.

Many records are enhanced in value, and in dramatic effect, by the use of colour. This is especially true of the recording of plant disease symptoms and the results of manurial trials such as make up a considerable proportion of the work at Rothamsted. On the other hand, where relative positions and the demonstration of movements are important, as at Askham Bryan, colour does not present any particular advantage. Other special techniques include the use of infra-red plates to record satisfactorily the lesions in the streak diseases of potato.

Recording does not, of course, cease with macroscopic objects, so far as Rothamsted is concerned. Illustrations were shown of records of the life-cycles of two soil organisms, crystals of plant viruses and of the lesions caused by such viruses, all of which involve photomicrography. The electron microscope now available at Rothamsted allows these records to be extended right down to the actual particles of virus and particles of clay (Fig. 1) at magnifications of 20–30 thousand diameters.

Fig. 1. THE CLAY MINERAL, HALLOYSITE. ELECTRON-MICROGRAPH TAKEN AT ROTHAMSTED BY DR F M. L. SHEFFIELD. × 20,000.

At the other end of the scale comes the use of aerial photographs (Fig. 2) for observing crops, the first of which were taken in 1925 by the R.A.F., at the request of Rothamsted. As is well known, aerial photographs show up differences completely invisible from the ground, and make possible the recording on a single plate of such differences in crops covering many acres.

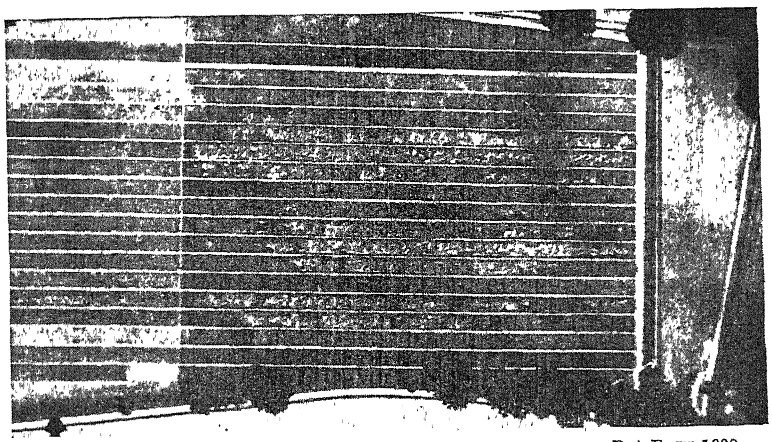

Fig. 2. BROADBALK FIELD, ROTHAMSTED. AERIAL PHOTOGRAPH BY R.A.F. IN 1930. THE DIFFERENTLY MANURED STRIPS, SOME WITH MUCH LODGING, STAND OUT PLAINLY. THE DIFFERENCES BETWEEN FALLOW (RIGHT) AND CROP (LEFT) DURING THE PRECEDING YEAR CAN ALSO BE SEEN.

Most of this 'still' recording work (except electron micrographs and aerial photographs) is done with modern small cameras; the Leitz Leica using 35 mm. film at Rothamsted, or the Zeiss Super Ikonta, giving $2\frac{1}{4}$ in. × $3\frac{1}{4}$ in. pictures at Askham Bryan. The former can be easily adapted for photomicrography by means of the 'Ibso' attachment, or by extension tubes and the sliding copy device, and both are in use at Rothamsted, as well as the Leitz 'Makam' camera, all of which are attached directly to a standard microscope.

Cinematography also finds a valuable place in this work. At Rothamsted, a comprehensive study has been made of the formation of cell inclusions in plants infected with virus, and several stills from this film were shown at the meeting. This film was made using exposures twelve times as long as normal, and when run at the normal rate gives a speeded-up effect which makes possible the detection of many movements which occur too slowly to be seen by direct observation. At Askham Bryan even more use is made of cinematography, partly for educational work and partly for studying the performance of machines. It has been found that the use of the 'aerial' shot is of great advantage in illustrating the movement of farm machinery; a special portable tower 20 ft. high, mounted on a lorry, is used for

making such shots. It is frequently of great advantage to run slow-motion films backwards. In such circumstances many points are obvious which can scarcely be noticed in a normal forward run. Illustrative excerpts of films of a potato digger and a disk-plough in action were shown.

The 'high light' of the afternoon was a speeded-up film of ploughing, made at Askham Bryan, to teach the best methods of laying out and ploughing a field so that idle running of plough and tractor is reduced to a minimum. A suitable field on Teesside overlooked by a cliff was the site, and the whole operation of setting out and ploughing was photographed from the top of the cliff, one picture being taken every second. In this way it was possible to compress two days ploughing into a film which could be shown at the normal rate in 40 minutes. The effect, as well as being very instructive, was amusing, as the tractor and plough appeared to move at about 50 m.p.h.

In addition to these direct methods of employing photography, two uses of the photographic emulsion at Rothamsted were touched upon: spectrographic analysis, both qualitative and quantitative, and X-ray diffraction work on clay minerals, in both of which the sensitive emulsion is used as a recording medium. Standard equipment is used for both—a Hilger medium quartz spectrograph and a Cambridge cylindrical powder camera of 28 mm. radius.

The spectrographic work includes the analysis of soils and plants for such elements as calcium, potassium, sodium, manganese and magnesium, and the detection and estimation of trace elements such as copper and boron and, in one or two recent instances, zinc, lead and chromium in toxic soils. Elements of the first group are estimated from lines excited in the Lundegärdh burner, and calibration curves are plotted with the ratio of line density to background density as ordinate and logarithms of the concentration as abscissæ. Elements of the second group are estimated from lines excited in the carbon and copper arc, using suitable internal standards; for example, tin for boron, the intensity of the tin line at 2496 A. being compared with the boron line at 2498 A.

The X-ray work is indispensable for the identification of minerals found in soil colloids and clays. The electron microscope will undoubtedly help greatly in this work, but as yet, insufficient data are available for the best use to be made of its possibilities. As a general rule, powder diagrams of clay minerals are poor because of the large scattering near the central beam, and aggregate diagrams must be used instead. However, the newer technique of replacing the air in the camera by hydrogen so cuts down the scattering as to make the former more valuable, particularly when obtained from an aggregate.

In the short discussion following the papers, Prof. Yule Bogue raised the question of the limitation of the electron microscope for the examination of biological material by the necessity for working in a vacuum. Dr. Crook, replying, pointed out that the vacuum is only one of the limitations, since the electron-scattering power of the oxygen atoms of the water which constitutes so large a proportion of living material is much greater than the scattering power of the carbon and nitrogen atoms which are the chief 'organic' constituents, and that we can at best hope for an image rather like a radiograph if it becomes possible to use wet material (say, by a freezing technique).

NUCLEAR ENERGY-LEVELS

THE following is a summary of a paper by P. Comparat* which came into the writer's hands by an unorthodox but topical procedure. Printed at Lyons in 1942, it was brought from France by an officer of the Free French forces in 1943. It then found its way into the hands of Prof. D. Saurat, of the French Department of King's College, London, who presented it to the College library. The work described therein was carried out at the Faculty of Sciences, Lyons, initially under the direction of Prof. J. Thibaud. The research occupied a period of four years, full time being devoted to the problem.

Introduction. The first demonstration of the transmutation of nitrogen by rapid neutrons was that of Feather in 1932, using a cloud expansion chamber. The suggested reaction was

$$^{14}N + n \rightarrow {}^{4}He + {}^{11}B + Q,$$

where Q was negative, thus corresponding to an endo-energetic reaction. Subsequent workers, for example, Chadwick and Goldhaber, showed in 1935 with an ionization chamber and a linear amplifier that exo-energetic disintegration also occurred in this reaction. About the same time, Kurie demonstrated that an alternative reaction occurred in which protons were emitted instead of α-particles.

The aim of Comparat's research was to measure the number of disintegrations at various energies of disintegration and to see if the magnitude and distribution of the energy-levels agreed with the current theory. By 1936 the discord between theory and experiment was considerable; the existing theory,

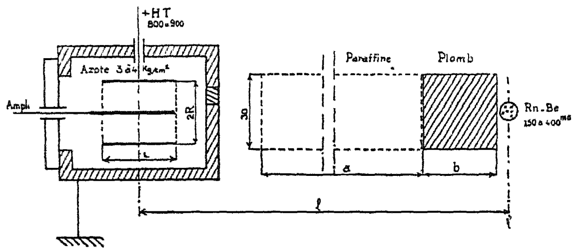

FIG. 1.

based on the two-body concept of the interaction of the incident neutron with the ^{14}N nucleus, predicted a few nuclear levels of considerable width. On the contrary, experiment showed numerous sharp levels. Again, theory predicted identical values for the diffusion and capture cross-sections of slow neutrons, whereas experiment showed a large ratio.

At about this time, Bohr introduced the concept of nuclear transmutation according to which the incident neutron amalgamates with the entire nucleus to form an intermediate nucleus (in this case ^{15}N) of appreciable duration. The intermediate nucleus afterwards disintegrates, for it is in an excited state, with the emission of a heavy particle, often accompanied by γ-radiation. In the special case of nitrogen bombarded by neutrons and boron bombarded by α-particles, the whole process is reversible, thus:

* "Disintegration of Nitrogen by Fast Neutrons; Distribution of the Energy Levels of N^{15}". By P. Comparat. Pp. 96. (Lyon, 1942.)

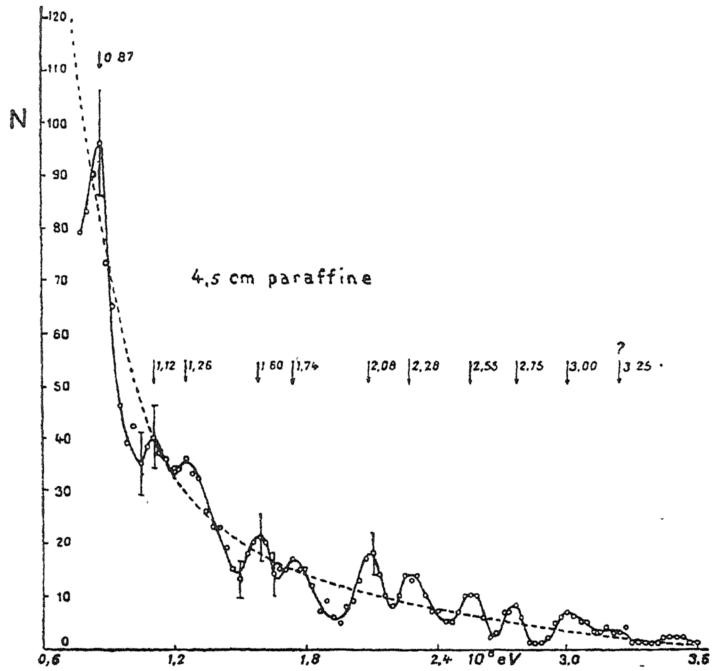

FIG. 2

$$^{14}N + {}^{1}n \rightarrow {}^{15}N \rightarrow {}^{11}B + {}^{4}He \qquad (1)$$

and also

$$^{11}B + {}^{4}He \rightarrow {}^{15}N \rightarrow {}^{14}N + {}^{1}n \qquad (2)$$

Hence the same resonance levels of ^{15}N should be registered in both cases, although the ^{15}N has been prepared by two quite different processes.

By 1937, several determinations had been made of the values of the excited levels of ^{15}N. Wilhelmy had demonstrated the existence of at least five distinct levels for reaction (1), while Maurer had recorded eight levels for reaction (2). Agreement was found between the two workers with four of the energy values. Of the remainder, two further values were assigned to ^{15}N, but the other two were attributed to the excited isotope ^{14}N, formed from the boron isotope ^{10}B, which was present in the experiment. Szalay confirmed Maurer's six levels for ^{15}N and added one more. Finally, Ortner and Protowinsky found a total of twelve groups of particles emitted by ^{15}N in the energy range 1–7 MV.

Experimental arrangement. A diagram of the experimental arrangement is shown in Fig. 1. The principle of the method consists in the use of a proportional counter connected to a linear amplifier and an oscillograph to record the total energy of disintegration of the α-particle together with that of the residual recoiling nucleus ^{11}B.

The counter has a cylindrical anode of about 25 mm. diameter; this was positively charged. The negative electrode was an axial filament 0·5–1 mm. in diameter. The pressure of nitrogen filling the counter was 4–5 atmosphere. At this pressure not only is the ionization increased but also the range of the disintegration products is sufficiently reduced to ensure their being entirely contained in the counter. Zinc was chosen as the metal for the outer electrode on the grounds of ease of purification; the total effective volume of the counter was 15–20 c.c. The potential difference between anode and cathode was about 900 volts and the counter filament was connected to the grid of the first amplifying valve.

The source of neutrons was the usual radon – beryllium mixture of strength 150–400 millicuries. Difficulties arising from the intense γ-radiation were reduced to a minimum by the insertion of absorbing blocks of lead. For details of the linear amplifier, reference is made to an earlier publication of Thibaud, Cartan and Comparat (1938). Special precautions were taken to maintain constant conditions of amplification; for example, changes in resistance were prevented by keeping the apparatus to within 5°–10° C. by thermostat. The sensitivity and reliability of the instrument was checked at frequent intervals with a standard polonium source. As a further check, the constancy of amplification was tested by measurement of the heights of the peaks observed on the oscillograph when a weak A.C. potential was applied to the ionization chamber. The oscillograph was of the Dubois electromagnetic type and this suffered from some zero displacement.

Measurements. The final results were expressed in the form of curves with $N = f\,(E_{a+B})$, where N is the number of peaks corresponding to a total energy of the disintegration products E_{a+B}. Apart from the error arising from statistical fluctuations, which could be readily estimated, the chief source of uncertainty lay in the determination of the exact heights of the peaks. These heights varied from 10 mm. to 50 mm. and it was estimated that measurements

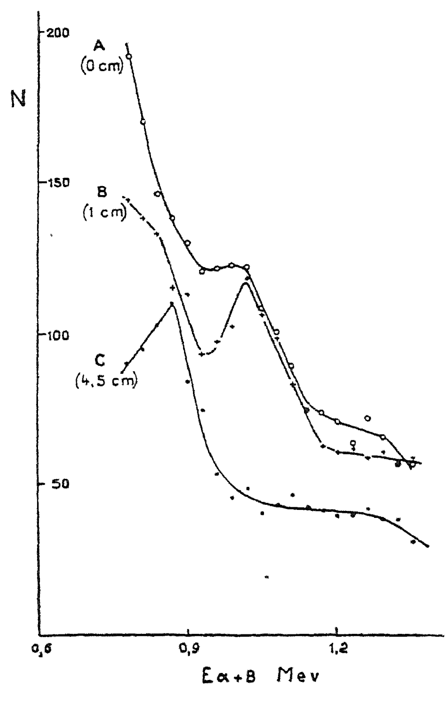

FIG. 3.

could be made to within 0·25–0·5 mm. Hence for smaller energies, corresponding to less than 1 MV., the maximum error was about 5 per cent, while it was correspondingly smaller at larger energies. With an intense γ-ray background, however, the zero band is widened considerably and the error may rise to 3–4 mm. The effect is strikingly demonstrated using α-particles from a polonium source. In the presence of γ-radiation, a typical α-ray peak is reduced in height by more than 50 per cent and increased in breadth by a factor of three or four times. Hence in deciding the reality of the existence of a flattened resonance group, some procedure such as the taking of several independent recordings was carried out to see if the point of inflexion was repeated.

Several sets of measurements were made with the same counter but under somewhat different experimental conditions. Some correspond to a layer of paraffin wax, 0–10 cm. thick, interposed between the source and the ionization chamber; others were made with no wax and only a sufficiently thick layer of lead to absorb most of the γ-radiation. As a control on the effect of the thermal neutrons, a thin layer of cadmium (0–5 mm.) could be inserted, and as a check on the behaviour of the ionization chamber, this could be filled with hydrogen instead of nitrogen. Typical of the measurements made were the following: (a) Ten recordings of 1 hour each made with different thicknesses of wax and with neutrons in the energy range 0·5–1·8 MV. (b) Three recordings of 4 hours each with three different thicknesses of wax —energy range of neutrons 0·75–3·6 MV., and so on.

Results. Some of the results obtained are shown in Figs. 2 and 3. In Fig. 2, the energy range of the incident neutrons was 0·75–3·6 MV. with a thickness of wax of 4·5 cm. The general behaviour, which is quite typical, shows a decrease of intensity with energy, together with distinct groups superposed on the smoothed curve, for example, at energies of 0·87, 1·12, 1·26, 1·60, 1·74, 2·08, 2·28, 2·55, 2·75 (3·00) and (3·25) MV. The figures in brackets are considered to be less well established than the others.

The effect of varying the thickness of the wax while maintaining other conditions constant is shown in Fig. 3 for the energy range 0·75–1·3 MV. Curve *A* was taken with wax absent, while curves *B* and *C* corresponded to thicknesses of wax of 1 cm. and 4·5 cm. respectively. It is noted that some maxima visible with one thickness of wax vanish with another thickness, while other maxima seem little affected. In particular, on passing from *A* to *B*, considerable diminution is observed in the number of low-energy particles, while on passing from *B* to *C* there is a further reduction in the number of low-energy particles; also a pronounced maximum appears at 0·87 MV., that previously at 1·02 MV. having disappeared. Further curves obtained for energies greater than 1·4 MV. give maxima the appearance and position of which are little affected by the presence and thickness of the wax.

Throughout this work, control experiments carried out with hydrogen replacing nitrogen in the ionization chamber gave a smooth curve with complete absence of peaks.

In all, thirty-two distinct groups of energies in the range 0·5–7 MV. were established as follows: 0·60, 0·75, 0·90, 1·05, 1·25, 1·40, 1·60, 1·75, 2·05, 2·25, (2·42), 2·6, 2·78, 3·03, 3·18, 3·33, 3·46, 3·63, 3·76, 4·02, 4·20, 4·36, 4·66, 4·82, 4·98, 5·27, 5·58, (6·04), (6·22), (6·41), (6·66), (7·00).

The average interval is about 0·2 MV. and the spacing is approximately uniform from one end of the energy scale to the other. There is some evidence for a doublet structure between 1·5 MV. and 4 MV. We may note that the rapid decrease in intensity with energy is partly due to the highly inhomogeneous distribution of energy of the neutrons from the source, but it is also partly due to the established decrease in the yield from nitrogen at higher neutron energies. The smoothed curve shows a minimum slope at about 3 MV.; this fact is discussed later.

Interpretation and Discussion. Perhaps the main result of the work is the interpretation of the thirty-two peaks as thirty-two energy-levels of ^{15}N. The question then arises whether all the groups consist of the same type of particles; in particular, do the low-energy groups, so affected in appearance by the introduction of paraffin wax, differ in any way from the groups of higher energy?

Before answering this question, Comparat points out comparisons with other workers. Wilhelmy, Maurer and others, found fewer groups with an interval of about 0·5 MV. Comparat claims that he includes these groups and has demonstrated the existence of the others owing to the superior sensitivity and selectivity of his apparatus, the resolving power of which was estimated at about 0·1 MV. In support of the reality of these levels he quotes recent work by Hansen which also shows a large number of levels although the source was quite different, the neutrons being obtained by the deuteron bombardment of beryllium or lithium.

The particles at lower energy, the production of which is affected by the thickness of paraffin wax, are considered to be protons produced by the reaction

$$^{14}\text{N} + {}^{1}n \rightarrow {}^{15}\text{N} \rightarrow {}^{14}\text{C} + {}^{1}\text{H} \qquad (3)$$

The particles of higher energy are α-particles produced according to reaction (1). The existence of two groups of particles explains the change in shape of the smoothed curve at about 3 MV. The curve is assumed to be compounded of two curves, one giving the yield of protons and the other that of α-particles, the latter curve having a maximum in the region of 3 MV. Careful examination shows that at very low energies the curve again shows a change of shape and this is attributed to a third type of interaction, namely, the elastic recoil of nitrogen nuclei on neutron impact.

Comparat conceives the possibility of an apparatus of higher resolving power demonstrating the existence of still more levels of ^{15}N. That the number of undiscovered levels should prove large he considers improbable on the practical grounds of the reproducibility of existing groups under conditions of varying sensitivity of his apparatus and on theoretical considerations of the spacing of the energy levels of light nuclei. Theory also supports the view that the low-energy particles are protons, since α-particles of such low energy would have very great difficulty in penetrating the potential barrier of the nitrogen nucleus.

By extending these experiments to oxygen and other elements a veritable nuclear spectroscopy of energy levels could be evolved. Valuable information on nuclear structure might then be forthcoming by examining the distribution and width of energy levels as a function of the number of nuclear particles, thus throwing light on the nature of the forces which bind these nuclear particles together.

F. C. CHAMPION.

CENTENARY OF ZOOLOGICAL TEACHING IN TRINITY COLLEGE, DUBLIN*

By PROF. J. BRONTË GATENBY

IN April one hundred years ago, the Board of Trinity College, Dublin, appointed Robert Ball as director of the Museum, with rooms and facilities for delivering lectures "illustrative of its contents and uses". The study of natural history in the University of Dublin began much earlier with the work of William and Thomas Molyneux, grandsons of the Englishman, Sir Thomas Molyneux, Chancellor of the Exchequer in Ireland in 1558. It was William Molyneux who, in 1684, demonstrated the flow of the blood in the newt, by means of the microscope. Whitley Stokes, father of the great Sir William Stokes, the physician, was appointed professor of natural history and curator of the Museum in 1815. His lectures dealt with "Volcanic Theory and Igneous Origin of Rocks, different portions of Zoology, Mineralogy and a Course in Mining and Metallurgy, and with the Natural Resources of Ireland". In 1791, Whitley Stokes was put on trial for his alleged implication in the United Irishmen Movement. He suffered much for his political opinions.

After the appointment of Robert Ball, the study of zoology was not pursued vigorously because his lectures did not have the status of a university subject. Ball, who was a Civil servant in the Chief Secretary's office, was retired on pension by the Government in 1852 on the ground that he "devoted much attention to scientific pursuits, and it was not expedient that public servants should be thus occupied". Ball died in 1857, and in the same year, after his death, the Rev. Samuel Haughton, F.R.S., later professor of geology, announced that the Board of Trinity College had promoted the study of zoology to a recognized university subject. Haughton took an active interest in the development of the School of Physic at Trinity College, and was responsible for bringing in first-class men from outside, such as Alexander Macalister (later professor of anatomy at Cambridge) and Daniel Cunningham (of Edinburgh), whose two sons, Admiral Sir Andrew Cunningham and General Sir Alan Cunningham, have had remarkable careers in recent times. After Robert Ball, the human anatomist Robert Harrison was appointed the first lecturer in zoology, a position he occupied for two years. Afterwards, Edward Percival Wright was appointed lecturer, and then in 1868 became the first professor of zoology. Wright transferred to the Botany School of Trinity College in 1869, and Alexander Macalister was brought in from the College of Surgeons of Ireland as professor of zoology (and comparative anatomy) in 1870. Later, Macalister became professor of human anatomy and chirurgery in Trinity College; he went to Cambridge in 1883. He was succeeded by William Henry Mackintosh as professor of zoology in 1879, who held the chair for forty-two years. He was at the same time registrar of the School of Physic, a position which needed considerable work; his interest in theology and missionary teaching also made inroads in his time, so that he did not publish any original work in the middle and later periods of his life.

It is of interest to zoologists to notice that George James Allman, the authority on Hydrozoa, was appointed professor of botany in Trinity College in 1844, and that the foundations of his exact knowledge of various groups of Cœlenterata were laid in Dublin. Allman was professor of botany in Dublin for twelve years, going to the chair of natural history in Edinburgh in 1856. James Allman was born at Bandon, Co. Cork, in 1812, and at first studied for the Irish Bar. Later he abandoned law and entered the College of Surgeons. He obtained what training he had in science, partly at the Irish College of Surgeons and partly in various private medical schools which then flourished in Great Britain and Ireland. Allman was attracted to the study of the Cœlenterata, after hearing a paper on a "large and beautiful collection of zoophytes" made by a Mr. A. H. Hassell, a Dublin amateur zoologist.

Another great College of Surgeons graduate who did much for the Trinity College School was Alexander Macalister. His father had been brought to Dublin in 1830, as secretary of the Sunday School Society of Ireland. When a small boy, Alexander Macalister was befriended by the curator of the Glasnevin Botanical Gardens, and on his advice, sent to the College of Surgeons at the age of fourteen, becoming a qualified medical man three years later. In view of the fact that Macalister's schooling was poor, it is astonishing that Dr. E. Barclay-Smith (*J. Anat.*, **54**; 1919–20) was able to write of him, "he was an able mathematician and familiar with many languages both living and dead. In Archæology, Zoology, Egyptology, Theology, Biblical History . . . he was an inexhaustible mine of knowledge". Macalister was for thirty-six years professor of anatomy at Cambridge. Macalister was born in 1844, the same year that George James Allman and Robert Ball became members of the staff of Trinity College, Dublin.

* From an address delivered to the Dublin University Biologica Association on May 22.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, June 10

INSTITUTE OF PHYSICS (ELECTRONICS GROUP) (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Discussion on "Some Aspects of High Vacuum Technique, viz., High Vacuum Gauges and Glass Manipulation" (to be opened by Dr. M. Pirani and Dr. B. P. Dudding).

Monday, June 12

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mr. Gordon Manley: "Topographical Features and the Climate of Britain".

Tuesday, June 13

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 1.30 p.m.—Dr. Elise J. Baumgartel: "Some Observations on the Prehistory of Egypt".

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Mr. C. H. Caffyn: "Rocks and their Structure".

Wednesday, June 14

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 3.30 p.m.—Discussion on "The Consumer's Supply Control Unit of the Future and its Effect on the Design of the Electricity Meter".

Thursday, June 15

BRITISH PSYCHOLOGICAL SOCIETY (INDUSTRIAL SECTION) (at the National Institute of Industrial Psychology, Aldwych House, Aldwych, London, W.C.2), at 1 p.m.—Mr. H. G. Maule: "Some Aspects of Factory Inspection in War Time".

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 3 p.m.—Dr. H. L. Hamburger: "The Mathematical and Historical Background of Hilbert's Theory of the Continuous Spectrum".

CHADWICK PUBLIC LECTURE (at the Chelsea Physic Garden, Swan Walk, Chelsea, London, S.W.3), at 4 p.m.—Dr. B. Barnes: "Vegetation and Human Well-Being".*

Saturday, June 17

BIOCHEMICAL SOCIETY (in the Physiology Department, University College, Dundee), at 2 p.m.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

APPRENTICE SUPERVISOR by large Engineering works to supervise educational and training schemes for apprentices and young persons (Nottingham district)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C 2 (quoting Reference No. C.2021XA) (June 14).

PROFESSOR OF BOTANY, ASSISTANT LECTURERS IN ECONOMIC HISTORY, GEOGRAPHY, BOTANY and ZOOLOGY, ORGANIZING TUTOR IN ADULT EDUCATION for Derbyshire, and a TUTOR IN PSYCHOLOGY—The Registrar, University College, Nottingham (June 14).

HENRY MECHAN CHAIR OF PUBLIC HEALTH—The Acting Secretary of University Court, The University, Glasgow (June 15).

SPEECH THERAPIST—The Director of Education, Education Offices, 15 John Street, Sunderland (June 16).

ASSISTANT (with Graduate or satisfactory industrial qualifications) to take MATHEMATICS, ENGINEERING, SCIENCE and DRAWING—The Principal, Hendon Technical College, The Burroughs, Hendon, London, N.W.4 (June 17).

LECTURER IN DIETETICS in connexion with Course leading to University of London Academic Post-Graduate Diploma in Dietetics—The Secretary, King's College of Household and Social Science, c/o University College, Leicester (June 17).

LECTURER IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Registrar, Technical College, Sunderland (June 17).

HEAD OF THE DEPARTMENT OF PHYSICS in the Bradford Technical College—The Director of Education, Town Hall, Bradford (June 17).

METALLURGIST by Firm of Engineers with wide interests (Ph.D., or equivalent, minimum technical qualification)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2286XA) (June 17).

ASSISTANT MASTER (full-time) in the Smith Junior Nautical School to teach mainly MATHEMATICS and SCIENCE—The Director of Education, City Hall, Cardiff (June 19).

HONOURS GRADUATE IN ENGINEERING to teach ENGINEERING SCIENCE, DRAWING and MATHEMATICS in the Merthyr Tydfil Technical School—The Director of Education, Education Department, Pontmorlais, Merthyr Tydfil, Glam. (June 21).

QUALIFIED ENGINEER by Tyre Manufacturers to direct experimental work on test rigs (location, Wiltshire)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2098XA) (June 21).

DEPUTY CHIEF ENGINEER (location, City of Manchester)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.834XA) (June 21).

DEPUTY BOROUGH ELECTRICAL ENGINEER (location, County Borough of St. Helens)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C 2 (quoting Reference No. D.851XA) (June 21).

PHYSICIST for essential War Work (work would include experience in various research departments of a North London firm specializing in optical instruments for scientific and industrial research and control)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.518XA) (June 21).

BOROUGH ELECTRICAL ENGINEER—The Town Clerk, Town Hall, Wimbledon, London, S.W.19 (June 23).

DEMONSTRATOR (man or woman) in the CHEMISTRY DEPARTMENT—The Warden and Secretary, London (Royal Free Hospital) School of Medicine for Women, 8 Hunter Street, Brunswick Square, London, W.C.1 (June 23).

PRINCIPAL ENGINEERING ASSISTANT on the permanent staff of the Buildings Department of the Kent County Council—The Council Architect, Kent County Council, Springfield, Maidstone (June 24).

ASSISTANT LECTURER IN MATHEMATICS—The Registrar, The University, Manchester 13 (June 26).

CHEMICAL ENGINEER for Aluminium Powder and Paste Works (location, Middlesex)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2149XA) (July 1).

LECTURER or SENIOR LECTURER IN GEOGRAPHY, and an ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Manchester 13 (July 10).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

LECTURER IN CIVIL ENGINEERING—The Registrar, Municipal College, Portsmouth.

LECTURER (full-time) IN MECHANICAL ENGINEERING—The Principal, Handsworth Technical College, Golds Hill Road, Handsworth, Birmingham 21.

GRADUATE IN ELECTRICAL ENGINEERING, and a GRADUATE (or equivalent qualification) IN BUILDING OR STRUCTURAL ENGINEERING, in the Darlington Technical College and Technical School—The Chief Education Officer, Education Offices, Darlington.

LECTURER IN ELECTRICAL ENGINEERING (mainly for teaching Senior Day and Evening students), a LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN CHEMISTRY (with subsidiary MATHEMATICS, PHYSICS, or BIOLOGY), in the Southend-on-Sea Municipal College—The Chief Education Officer, Education Offices, Warrior Square, Southend-on-Sea.

LECTURER (full-time) IN MECHANICAL ENGINEERING, and a MASTER to teach SCIENCE and MATHEMATICS in the Junior Technical School for Boys—The Principal, Wimbledon Technical College, Gladstone Road, Wimbledon, London, S.W.19.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Annual Report for 1942–43 of the Research Departments of the College of the Pharmaceutical Society of Great Britain. Pp. 42 (London: Pharmaceutical Society.) [55

Council for Education in Appreciation of Physical Environment First Annual Report. Pp. 7. (London: Council for Education in Appreciation of Physical Environment.) [85

Principles of Good Lighting. (Lighting Reconstruction Pamphlet, No. 1.) Pp. 7. The Lighting of Public Buildings. (Lighting Reconstruction Pamphlet, No. 2.) Pp. 11. The Lighting of Schools. (Lighting Reconstruction Pamphlet, No. 3.) Pp. 14. (London: Illuminating Engineering Society.) [85

Gas Research Board. Fourth Annual Report of the Council of the Gas Research Board. (Communication GRB 8) Pp. 32. (London: Gas Research Board.) [85

Scientific Proceedings of the Royal Dublin Society. Vol. 23 (N.S.), No. 20: Sea Trout of the Waterville (Currane) River. By Arthur E. J. Went. Pp. 201–213. 1*s*. 6*d*. Vol. 23 (N.S.), No. 21: Reaction of *p*-Dimethylaminobenzaldehyde with Aromatic Amino Compounds By A. E. A. Werner. Pp. 214–221. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [85

Iron and Steel Institute. Report of Council for 1943. Pp. 30. (London: Iron and Steel Institute.) [95

A Reading List for Relief Workers. Pp. 36. (London and New York: Royal Institute of International Affairs.) 1*s*. net. [95

A Short Account of the Moss Exchange Club and the British Bryological Society. Compiled from the Annual Reports by Eleonora Armitage. Pp. 24. (Ross: The Author, Dadnor.) [95

Report of the Marlborough College Natural History Society for the Year 1943. (No. 92.) Pp 24. (Marlborough: Marlborough College.) 1*s*. 6*d*.; to non-Members, 5*s*. [155

Proceedings of the Royal Irish Academy. Vol. 49, Section C, No. 5: The Galway Fishery. By Arthur E. J. Went. Pp. 187–219 + plate 13. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 2*s*. [155

Annual Report of the Oundle School Natural History Society Pp. 22. (Oundle: Oundle School.) [155

Brompton Hospital Reports. a Collection of Papers recently published from the Hospital. Vol. 12, 1943. Pp. vii + 163. (London: Brompton Hospital.) 8*s*. net. [185

Other Countries

Imperial College of Tropical Agriculture: Department of Mycology and Bacteriology. Memoir No. 8: Studies in the Witches' Broom Disease of Cacao caused by *Marasmius perniciosus* Stahel, Part 2: Field Studies and Control Methods. By R. E. D. Baker and S. H. Crowdy. Pp. 28 + 7 plates. (Trinidad: Imperial College of Tropical Agriculture.) 3*s*. net. [194

U.S. Department of Agriculture. Miscellaneous Publication No. 526: Insecticides and Equipment for Controlling Insects on Fruits and Vegetables. By N. F. Coward and C. A. Weigel, C. M. Smith and L. F. Steiner. Pp. 52. (Washington, D.C.: Government Printing Office.) 10 cents. [194

Yale University Publications in Anthropology, Nos. 25 and 26: The Ciboney Culture of Cayo Redondo, Cuba, by Cornelius Osgood; Archeology of the Maniabon Hills, Cuba, by Irving Rouse. Pp. 252 + 14 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press.) 23*s*. 6*d*. net. [204

Natural and Synthetic Fibers: a Looseleaf Literature and Patent Digest. Edited by Milton Harris and H. Mark. First Year, 1944, 12 issues. First issue. Pp. 64. (New York: Interscience Publishers, Inc.) Subscription, 60 dollars a year; Binder, 3 dollars. [214

Fats, Oils, Detergents: a Looseleaf Abstract Service. First Year, 1944, 12 issues. First issue. Pp. 48. (New York: Interscience Publishers, Inc.) Subscription, 36 dollars a year; Binder, 3 dollars. [244

Brooklyn Botanic Garden Record. Vol. 33, No. 1: Thirty-third Annual Report of the Brooklyn Botanic Garden, 1943. Pp. 68. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [254

Legislative Council, Fiji. Council Paper No. 18: Annual Report of the Medical Department for 1942. Pp. 24. (Suva: Government Printer.) [264

India Central Jute Committee. Agricultural Research Memoir No. 1: Anatomical Studies on Jute (Corchorus) with Special Reference to the Formation of Fibre. By S. S. Ghosh, K. R. Rao and J. S. Patel. Pp. iii + 24 + 7 plates. 1·8 rupees; 2*s*. Agricultural Research Memoir No. 2: Anatomy of Retted Jute. By J. S. Patel and S. S. Ghosh. Pp. iii + 16 + 4 plates. 1 rupee; 1*s*. 6*d*. (Calcutta: India Central Jute Committee.) [274

Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 60: Preparation of Compost Manure from Town Wastes. By Dr. C. N. Acharya. Pp. 10. (Delhi: Manager of Publications.) 7 annas; 8*d*. [284

American Philosophical Society. Year Book 1942, January 1, 1942—December 31, 1942. Pp. 398. (Philadelphia: American Philosophical Society.) [15

United States Tariff Commission. United States Consumption of Food in Terms of Fats, Proteins, Carbohydrates and Calories, 1939–43. Pp. ii + 123. (Washington, D.C.: United States Tariff Commission.) [25

Geological Survey of British Guiana. Bulletin No. 16: The Geology and Geography of the Towakaima Region, Upper Barama Valley, North West District. By D. W. Bishopp. Pp. iv + 28. 24 cents. Bulletin No. 17: Report on the Geology, Gold and Diamond Deposits of the Awarapari-Issineru-Putareng Area, Upper Mazaruni River. By Dr. B. A. Bryn Davies. Pp. 30 + 2 plates. 24 cents; Photographic Supplement. Pp. ii + 17 plates. 24 cents. Bulletin No. 18: Report on the Geology of the Waikuri District, Cuyuni River. By S. Bracewell. Pp. 16. 24 cents. Bulletin No. 19: Report on the Area between Arakaka and Kokerit, North West District. By S. Bracewell. Pp. 32 + 4 plates. 24 cents. (Georgetown: Geological Survey of British Guiana.) [95

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SCIENTIFIC APPROACH TO HOUSING PROBLEMS

THERE can be no mistaking the extent to which dissatisfaction is rapidly growing at the Government's failure to take and announce its fundamental decisions in regard to the planning and development of the land and the location of industry in Britain. Mr. Dalton, speaking in the House of Commons on June 7, stated that the Government accepts the main ideas of the Barlow Report, but we still await information as to the measures by which effect is to be given to the general policy of planning. The preparation of detailed housing programmes is already a matter of urgency, but is as yet impossible because neither planning authorities nor private developers know what are to be their respective powers. Again, housing policy is intimately related with industrial location policy, for local authorities cannot proceed with housing plans if they are uncertain where the people are to be working.

What perhaps has brought home generally the danger of piecemeal planning is the Minister of Health's admission that the first 300,000 permanent houses are to be built on sites chosen without reference to any sort of national policy for planning the use of land. More than half these sites were bought by authorities whose choice was dictated by local interests and circumscribed by private rights, and Mr. Willink appeared to be quite unconcerned that the remainder should be purchased by authorities still without guidance as to whether public interest is to be the effective determinant in the use of land, let alone whether, from the national point of view, the particular sites those authorities have in mind ought to be used for housing. This is the negation of national planning, and has rightly received forthright condemnation in one of the latest interim reports from the Central Committee on Post-War Reconstruction of the Conservative and Unionist Party Organization.

This report, "Foundation for Housing", prepared by the Conservative Sub-Committee on Housing, with Sir Harold Bellman, J. D. Trustram Eve and K. M. Marr-Johnson as its technical advisers, insists that the first step in framing a housing policy must be to determine where the houses shall be built. This depends first and foremost on the location of industry; but while housing is a non-controversial issue in party politics to-day, many fail to realize, as this report points out, that without planning on national lines a successful housing policy is impracticable. The sub-committee "views with grave apprehension the results which are likely to accrue if housing policy is pressed ahead without preliminary decisions on questions of location of industry and in advance of a solution of the problem of compensation and betterment. . . . Activities of different Government Departments, valuable as they may be, are no substitute for a single comprehensive policy on the issues of location of industry and the protection of agricultural land. We cannot therefore press too strongly for the formulation without delay of national policy on these fundamental points."

In this attitude the Committee should be assured of wide support. It has been repeatedly urged in these columns that failures and faults in our inter-war legislation have been due to the absence of a sufficiently national and positive policy in such matters as the geographical distribution of industry, the protection of agriculture, the co-ordination of transport and the control of the growth of our cities. The warning in this report that, in the absence of an early announcement of the Government's planning policy, the train of housing is in danger of being diverted on to the wrong track, needs the more emphasis in view of the approval with which the pre-fabricated houses have been welcomed, in spite of the warning that they are a temporary expedient.

A particular recommendation of the report is that, as a first step to a forecast of the future distribution of the industrial population, an immediate study should be made by the central authority of the location and extent of war factories throughout Great Britain, of the transport facilities which are available in each case and of the provision, temporary or permanent, for the accommodation of labour. That recommendation is in keeping with the recent report of the Welsh Reconstruction Advisory Council*, which indicates that the Council regards the conduct of a continuous survey of current developments in industry, agriculture and the public services as an important part of its task, and emphasizes the desirability of the regional offices of the Ministry of Production and the Supply Ministries keeping the Council informed of important changes in the location of new plants, in production programmes at particular existing plants and in projects for the post-war use of war factories. A like emphasis on organic evolution, the continual reaction to changing environment based on full technical knowledge, not merely of raw materials and processes, but also of markets, and the participation of scientific and technical workers, not as the tools but as the guides of the politician and financier, characterizes the presidential address of Dr. F. J. North to the South Wales Institute of Engineers.

None the less, the Conservative Sub-Committee insists on its main point, that only by creating effective machinery for the attainment of the three main objectives agreed upon unanimously by the Barlow Commission, and by solving in one way or another the problem of compensation and betterment, can the Government lay the foundation of a successful long-term housing policy. While the Committee welcomes the appointment of a Minister of Reconstruction, it looks for the publication of the promised White Paper, in which it hopes to find proposals for the early creation of a central authority as envisaged in the Scott and Uthwatt Reports, as well as the Barlow Report. In the absence of a single comprehensive policy on the issues of the location of industry and the protection of agricultural land, it sees no alternative to the continued promiscuous growth of the cities of Britain and the drift of the people from the countryside, with ensuing aggravation of all the evils which must inevitably result.

Nothing that has yet been said on behalf of the Government has dispelled a widespread suspicion that official allegiance to national planning is little more than the enforced acknowledgment of a principle which it would be political folly to disregard, but which it has proved inconvenient to translate into practice. Similarly, the belief is hardening that the reason for the delay is due not to the admitted difficulty of reaching an agreed decision on the compensation and betterment proposals of the Uthwatt Committee, but to unwillingness to do so. In its memoranda to local authorities last November, the Ministry of Town and Country Planning gave a lead, but the plan for Plymouth recently published shows how weak are the Ministry's suggestions for avoiding coastal ribbon development in the present uncertainty and absence of legal powers.

This plan for Plymouth is in some respects more far-reaching than the County of London Plan prepared for the London County Council by J. H. Forshaw and Prof. Abercrombie. More than a key to the future of Plymouth itself, it aims at preserving the diverse features of the neighbouring area, one of the most beautiful regions of England, and for this purpose Prof. Abercrombie and Mr. J. Paton Watson's proposals assume the support of the neighbouring rural and county councils. They visualize the metamorphosis of the city from an area clogged and untidy into one decentralized into planned communities, on the basis of a stable population, with the central mass lightened, and a series of suburban satellites.

In spite of the wide appeal of this attempt, not merely to remodel Plymouth but also to improve for the nation the amenities of an entire region, these features of the plan are not the most important at the moment. Here once again is conclusive demonstration that housing by itself is not enough. Still more important is the demonstration that with proper planning and with the aid of the Government by pooling nationally the differing values of land, much of the cost of the scheme can be offset, and any small cash loss would be more than balanced by gains in other ways. Again, here is a convincing demonstration of the national value—if not necessity—of co-operation on a regional basis in planning reconstruction. Only by such co-operation can the district be safeguarded from irreparable damage.

There could, in fact, have been no more timely demonstration to the public and to Parliament of the kind of Government help that is essential. Here is the evidence that local reconstruction cannot be carried out either by private enterprise or public bodies without the security which Parliament must give. Statutory powers are needed now for the immediate acquisition as reconstruction areas of districts which have been 'blitzed' and for their purchase at pegged prices of land. Public ownership is vital, and the local authority must also be able to look to both a central pool for compensation and to a regional policy and a national pool so that betterment and depreciation may be equated.

The first major task of the housing programme

* Welsh Reconstruction Advisory Council. First Interim Report. (London: H.M. Stationery Office, 1944.) 2s. net.

in Britain is clearly that of making good the damage due to enemy action and the slower but equally destructive ravages of war-time neglect. Then will come the work of overtaking the arrears of a hundred years neglect by providing every family with a separate and generously designed dwelling and by establishing an adequate reserve. Both these tasks are, as the Plymouth plan shows, related to planning in wider fields, and this is no less true of housing policy in the next period when it is determined by the need for replacement. This is well brought out in a P E P broadsheet entitled "Old Houses" which, giving an interesting analysis of the social obsolescence of housing, emphasizes that the volume of replacement should depend on the number of new houses that are needed for their own sake. Any decision as to the amount of replacement should be based on a close analysis of the causes of obsolescence in housing.

This broadsheet is thus of special interest in view of the temporary character of the prefabricated houses intended to meet the immediate post-war shortage, and should facilitate the fuller understanding of this complex aspect of the housing problem. While the rate of deterioration of a house depends on the soundness of the original building, the broadsheet emphasizes that social changes can make houses out of date just as surely as any deterioration in the physical structure. Many of the points made in regard to the effect of changes in the living habits of the middle classes, the character of a neighbourhood, the growth of road traffic or industrial location are so obvious as to be almost trite, but their implications are seldom thought out or realized, and the broadsheet proceeds further to show the exact bearing of obsolescence on the post-war housing programme.

Obsolete housing can be dealt with either radically by demolition and replacement, as in slum clearance, or remedially by rehabilitation. The former is the proper course where the original design and layout were poor and mean; but the only sound test as to when the original design and layout should be considered so inadequate as to call for demolition must be selective and designed to destroy and replace none except unfit houses whatever their age. P E P suggests that local authorities should be in a position to adopt a flexible minimum standard and to require all houses to conform to that standard. It is equally important, though more difficult, to reduce the rate of obsolescence of new houses, and in this field the report of the British Building Mission on Building Methods in the United States and the admirable series of Post-War Building Studies which are being issued by the Ministry of Works may well be expected to encourage building the new post-war houses to the highest available standard, while at the same time providing as much scope as possible for flexibility in internal and external arrangements.

Rehabilitation, in its two forms of reconditioning and of conversion, can also play an important part in the post-war housing programme, and the P E P broadsheet points out that little is yet known about the labour economies which would result from large-scale rehabilitation and conversion. The experimental work now being done in Westminster, Islington and other London boroughs should throw some light on the only means by which many houses could be made satisfactory for a new purpose. Moreover, reconditioning and conversion, even if not profitable for individual house-owners, may be worth while from the point of view of the community as a whole, and may, therefore, deserve a subsidy. Again, they have another advantage in checking urban sprawl at a time when the present phase of growth of the town population, as well as of the population at large, is probably approaching its end.

The social function of housing, beyond the mere provision of homes, in promoting also association, neighbourliness, civic sense, architectural dignity, amenity and a feeling of stability finds worthy expression in the Plymouth plan; but it is no easy task to provide a system of housing and type of lay-out which will continuously relate the fabric of a constantly changing society to its even more rapidly changing needs. That is a task in which the constant and thorough application of scientific research to the technical problems of construction is essential, and also the no less assiduous examination of the many social and economic problems involved in the same impartial scientific spirit. The first and most obvious precautionary measure is, as the P E P broadsheet observes, to see that new housing is built to a standard of accommodation and size which is closely related to the needs of the coming generation of householders; that it is built to a scale and in conformity with a lay-out which will permit the establishment and maintenance of a healthy society, provided with public and communal buildings and the requisite social services; that precaution is taken against the hazards of congestion, overgrowth and malformation by an intelligent development plan, understood and appreciated by officials and citizens alike; and that the standards of other community needs—roads, recreation grounds, shops—should be adequate and in proportion.

A secondary objective would be flexibility both in the interior planning of a house, so as to allow some alteration and extension without prohibitive cost, and also as between different dwellings in the same neighbourhood in order to facilitate moves from a smaller to a larger house or vice versa as the family increases or contracts. The maintenance of adequate standards and the decrease of the rate of obsolescence will only in part depend on new housing in the new decades. The major part of the problem will be to deal with existing housing and still more with existing communications and towns, and here the P E P broadsheet leads us back to the fundamental need for control of the use of land in the public interest. The many instances of social obsolescence have arisen out of the chance pattern of land ownerships in old and growing towns, and effective reconstruction can only be carried out on the basis of a temporary or permanent acquisition of large areas of land by a planning authority.

Given the machinery for dealing comprehensively with demolition, development and re-development to a prepared plan and time-table, questions of policy can then be determined with reference to the density

of housing, the case for temporary construction, the life of buildings (for planning purposes) and their functional grouping. But, if the community is to enjoy in its housing programme the full benefits and possibilities which science has placed at its command, it is no less essential that at the centre there should be taken speedily the decisions in regard to the control of land and the problems of betterment and compensation which must be made by the central government. Then local authorities or individuals can prepare and give effect to the plans designed, not only to provide homes, but also to give them a pattern and a setting which preserve as much as possible of our cultural and scenic heritage.

EXAMINATIONS EXAMINED

The Case for Examinations

An Account of their Place in Education with some Proposals for their Reform. By J. L. Brereton. Pp. viii+226. (Cambridge: At the University Press, 1944.) 8*s*. 6*d*. net.

THE author of this book has set before himself three aims: to present a case in favour of examinations, to put forward proposals for their reform, and to give an account of their influence, chiefly in the field of secondary education from about 1858 onwards. As to the third of these aims, his abundant experience in connexion with the Cambridge Local Examinations has enabled him to achieve a noteworthy success. The clear record of historical fact certainly makes the book useful for reference. As to the first two aims, no one knows better than the author that he has been treading on extremely debatable ground.

The book was practically finished when the Norwood Report on Curriculum and Examinations in Secondary Schools was published; but the author was able to add a chapter on that report. The reviewer, having perused Mr. Brereton's book as originally completed, was quite prepared to find him in his final chapter smiting hip and thigh the concocters of the Norwood document, and the expectation was fulfilled. It would be hard to find two pieces of writing on the same theme more utterly at variance than Mr. Brereton's book and the Norwood Report. According to the former, the very life and soul of education are derived from the stimulus afforded by mass examinations, which only need reform in certain directions. According to the latter, no true education is possible in the secondary schools until the prevailing mass examinations, yielding in plenty a stimulus of the wrong kind, have been reformed out of existence.

Manifestly such irreconcilable differences of opinion must be due to causes which are fundamental. Those causes are not far to seek. In their preface, the signatories of the Norwood Report announce their intention to set out suggestions for the freer treatment of the curriculum which is demanded by a "child-centred education" and made possible by the greater freedom secured by their proposed reorganization of examinations. The belief in the child, the individual child, as the centre of all education, gives, they say, a perspective and a vision to education, and assigns to their right places as means to an end all "the paraphernalia of education"—including examinations. That is the idea which pervades the Report from beginning to end. The same idea was taken as axiomatic in the White Paper, which preceded the Education Bill. There we read that "the key-note of the new system will be that the child is the centre of education", not, be it noted, the official or the taxpayer or even the teacher, but the child. Further, to quote the Norwood Report again, "an education which is really child-centred can come about only if freedom is allowed to those who alone can make the individual child the centre of education, namely, the teachers themselves".

From the freer treatment of the curriculum thus based on a child-centred education Mr. Brereton entirely dissents. He is quite clear that "Great Britain will not maintain her position in the modern world unless she repudiates the educational philosophy set out in the Norwood Report". He is clear that the Board of Education, in holding as "a cardinal principle" that the examination should follow the curriculum, not determine it, has only upheld a theory which everyone knows to be ignored in practice—and rightly so. He makes much of the stimulus which the prospect of an examination supplies, but little or nothing of the stimulus inherent in the situation when lively youngsters and a capable teacher are jointly intent on the job in hand. He offers definitions of external and internal examinations which imply the superiority of the former because they involve the element of competition. He defends competition, and evidently has little use for the modern progressive teacher's preference for a co-operative ethic in the classroom.

Seeing that an examination syllabus must go far to settle the content of the curriculum, Mr. Brereton makes good suggestions for reform, and in doing so he quotes John Dewey to good purpose. Nevertheless, the name of Dewey looks rather out of place in a book written in defence of our English examination system. The natural opposite of the child-centred school is the adult-centred school. Until recently, the latter held the field, as it largely does to this day. In the present century, however, the idea of child-centred education has emerged almost simultaneously in England and the United States. As an American writer says, "the doctrine of self-expression is assuming a rôle co-ordinate in importance with that of adaptation". From the first, that is, from about 1900, Dewey has been the inspirer of child-centred education in America and to some extent in England. He has, however, shared a common fate of reformers in being misunderstood. Some of his followers, with their project methods, for example, have overdone the sound principle of free self-expression on the part of the child. In his last book, dated 1938, Dewey seeks to correct the tendency of "many of the newer schools to make little or nothing of organised subject-matter of study and to proceed as if any form of direction and guidance by adults were an invasion of individual freedom". In fact, Dewey's philosophy of experience does recognize, even more directly than Mr. Brereton seems to have noticed, what Mr. Brereton calls "the close inter-connection between the development of the higher faculties of the individual and the world of men and things in which he lives". But there is this difference. Mr. Brereton has lived and worked where the examiner has been in the saddle and has ridden that portion of mankind that goes to school, whereas Dewey only mentions examinations incidentally, and only to lament "the spectacle of professional educators decrying interest while they uphold with great dignity the need of

reliance upon examinations" and kindred "paraphernalia". He issues a warning to well-meaning enthusiasts, but there is not the slightest evidence that he would apply such an antidote as our vast and complicated examination machine. He would be more likely to say, trust your teachers, and if they cannot even trust themselves, reform your system until they feel strong enough to do so. In other words, he would assuredly prefer the spirit of the Norwood Report to that of Mr. Brereton's book.

T. RAYMONT.

BRITISH ELECTRIC POWER STATION PRACTICE

Electric Power Stations

By T. H. Carr. Vol. 1. Second edition revised and enlarged. Pp. xii+507. (London: Chapman and Hall, Ltd., 1944.) 32*s.* net.

MORE than 10 per cent of all the coal mined in Great Britain is used in electric power stations, and the electrical energy produced in these stations is an important factor in determining the standard of living of the population of Great Britain. Books on power stations are scarce, so that the appearance of a new edition of the only up-to-date British publication is a matter of considerable interest and importance.

The volume under review comprises a foreword by Sir Leonard Pearce, two author's prefaces, nine chapters and a subject index. The chapters deal in turn with some fundamentals of station design, civil engineering and buildings, circulating water systems, cooling towers, coal-handling plant, ash-handling plant, boiler plant, pipework and turbine plant. Twenty-nine pages are devoted to fundamentals of design. They provide an ill-assorted series of what purport to be general principles relating to plant rating, choice of thermal cycle, choice of voltage of generation, and station operation. Civil engineering works and buildings are considered in a more comprehensible manner; but the treatment remains scrappy. Some of the facts provided, for example, the tables giving floor areas and volumes of boiler and turbine houses per kW. installed, are potentially useful to those who are interested in power station design. Circulating water systems and cooling towers are described in some detail; but insufficient emphasis is given to the fact that modern developments in cooling tower design and construction are having a profound influence on the economics of electricity supply. Coal and ash-handling plants of all the principal types encountered in Great Britain are briefly commented on in the light of operating experience. The chapter on boiler plant deals with chain grate and retort stokers, pulverized fuel systems and apparatus, natural circulation and forced circulation, steam generators, and instruments used in connexion with steam production. A chapter is devoted solely to steam and water pipes, joints and valves. Turbines and their accessories are considered in the final chapter.

The volume is illustrated by 249 figures which are in the main well-chosen, apart from a few which are too elementary to justify their inclusion in an important treatise. The figures provide more and better information than does the descriptive matter.

The author has done his best to emphasize points of special importance, and has been unsparing in his efforts to safeguard his readers from dangers and difficulties encountered in power station design, construction and operation.

His work is pervaded by a sort of naïve enthusiasm which is quite infectious; but this leads him to make numerous interjections which, although intended to help, actually hinder the reader from getting a proper grasp of the subject in general. The English is frequently so faulty that many sentences are incomprehensible. and the work is further marred by several gross typographical errors. The few calculations which are included are of an elementary and inconsequential nature.

There are only scrappy references to American or other foreign plants, and even those which are included are not direct. Power station development in the United States has always been in advance of that in the rest of the world, and many European stations have novel and interesting features which should be made known to our home engineers.

The author has made an effort to supply a long-felt want in British engineering literature. It is evident from the fact that the second edition of his book has been called for within three years that he has had some measure of success. In the opinion of the reviewer, however, the volume under consideration is in most respects of indifferent quality, and does not adequately meet the requirements of specialists interested in power station design, construction or operation.

C. W. MARSHALL.

LANGUAGES, NATURAL AND ARTIFICIAL

The Loom of Language

A Guide to Foreign Languages for the Home Student. By Frederick Bodmer. Edited and arranged by Lancelot Hogben. (Primers for the Age of Plenty, No. 3.) Pp. 670. (London: George Allen and Unwin, Ltd., 1943.) 15*s.* net.

TO anyone who learnt languages in the traditional fashion, Dr. Bodmer's work must bring a feeling of frustration. In the time spent at the average school on memorizing one language, the intelligent student could, by the method here displayed, learn to understand a group of related languages.

The first part of the book deals with the evolution of languages, with alphabet, accidence, syntax and classification. The second part instructs the reader first how to begin the task of learning the essentials of a language, and then gives the basis of Teutonic grammar and of the languages of Latin descent. Part 3 deals shortly with those languages, such as Russian and Chinese, furthest removed from our own, with the history of the artificial languages, and with a suggestion for yet another planned language for international use. Finally, there is a series of basic vocabularies for the Teutonic and Romance languages and of Greek roots of international currency.

Anyone with some knowledge of European languages reading this book will emerge at the other end with an enriched vocabulary, a sounder understanding of their meaning, and a new capacity for interpreting the unknown words in his future foreign reading. In school an enthusiastic teacher could have no better text-book.

For an adult who wishes to learn a language, the reviewer offers the following prescription. Prepare

the way and mount enthusiasm by way of "The Gift of Tongues" by Margaret Schlauch. Proceed next to Part 2 of "The Loom of Language", and finish with the appropriate volume from "The Basis and Essentials Series" edited by Charles Duff. It is only fair to say that these suggested volumes are included in Dr. Bodmer's bibliography.

The reviewer, after the toil of learning French and the consequent enjoyment of its literature, was dashed to discover that the author rates it as having an "ostentation-value as a female embellishment". Although it is no stigma to be unable to speak French, one doubts whether it is wise to applaud Lloyd George and Wilson because Clemenceau had to speak to them in English. Perhaps the outcome of the conversation might have been different if the Anglo-Americans had had some knowledge of French, and with it an inkling of the workings of the French mind.

The planned language here outlined appears in theory to have many points in its favour. In its final form as seen in "Interglossa" by Prof. L. Hogben, one fears that it will probably meet the same fate as its predecessors. If an international language is to be planned, might it not be better to start from a basic accepted language with an added international vocabulary of scientific and technical terms?

An edified and entertained reviewer recommends this book to all students of languages. If any such students happen to have bourgeois tendencies, they will no doubt be occasionally galled by the author's political interpolations to about the same extent as the author would be if he read "Who are the People" by Colm Brogan. J. MARSHALL.

ELEMENTARY PHYSICAL CHEMISTRY

Elementary Physical Chemistry

By Prof. M. Randall and Prof. L. Esther Young. Pp. xiv+455. (Berkeley, Calif.: Randall and Sons, 1942.) 4.50 dollars.

Introduction to Physical Chemistry

By Prof. Alexander Findlay. Second edition, revised and enlarged. Pp. vii+582. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1942.) 15*s*. net.

RANDALL AND YOUNG'S book is described on the cover as for second- and third-year college students and as a broad survey of elementary physical chemistry. It is not easy to equate this with a corresponding treatment in Great Britain. Some of the topics are elaborated in great detail and others, in the reviewer's opinion, are considerably advanced. The early introduction of the idea of flow-sheets for simple reactions is a novelty, and the precise definitions of concentrations and the implications which flow from them is a good but unusual feature in elementary books of this kind.

The volume is produced, possibly owing to war exigencies, in what looks like imitation typescript and is termed 'photolith'. This method gives good illustrations, which are often drawn from industrial practice; but it is rather trying to the eyes and not conducive to prolonged reading. This may be due to habit.

Findlay's volume is written from the British point of view, and its treatment is in marked contrast to that of "Randall and Young". It deals much more with the experimental side of the subject, and does not go so deeply or so dogmatically into theory. It covers most of the usual field in this subject and should prove a useful aid to students who are beginners as well as to those who are a little more advanced. One characteristic feature is the assignment of dates to the workers who are mentioned.

The book starts on the basis of the atomic theory and ends with an elementary discussion of heterogeneous equilibrium. The thermodynamical treatment is a little old-fashioned; activity is only dealt with in elementary fashion. These may be matters of personal taste. The ambiguities in methods of expressing concentration which become important in all but very dilute solutions are not very clearly brought out. This may be an obsession of the reviewer and could scarcely be expected in a book of this standard; nevertheless clarity in such definitions is very helpful in more advanced work.

CHEMICAL ANALYSIS

Textbook of Quantitative Inorganic Analysis

By Prof. I. M. Kolthoff and Prof. E. B. Sandell. Revised edition. Pp. xvii+794. (New York: The Macmillan Company, 1943.) 21*s*. net.

Systematic Qualitative Organic Analysis

By H. Middleton. Second edition. Pp. viii+280. (London: Edward Arnold and Co., 1943.) 8*s*. 6*d*. net.

BOTH these text-books have this in common, that they have entered into a second edition and that deservedly, for they are extremely useful works which, although primarily meant for university students, are profitable to chemists who have proceeded beyond this stage. There, however, the resemblance ends for, apart from the fact that one deals with quantitative inorganic and the other with qualitative organic analysis, they differ markedly in the manner of treatment of their respective subjects. The former is a comprehensive text-book dealing very thoroughly with the theory and quite adequately with the practice of inorganic analysis, while the latter is severely practical and is meant almost entirely for laboratory use. Perhaps both books could gain something one from the other; the American work would benefit if a few more practical examples were included, particularly in electro-analysis, in amperometric titrations and in nephelometry; Mr. Middleton's book would undoubtedly gain if, here and there, some theory were introduced.

In this new edition of "Kolthoff and Sandell" (previously reviewed in NATURE, **139**, 821; 1937) a number of the chapters have been revised, while the sections on errors, organic reagents and spectrophotometry have been expanded. There has also been introduced a discussion on polarographic analysis or, as the authors prefer to term it, amperometric titrations. A folder has been added inside the back cover and carries a leaflet containing atomic weight tables, four-figure logarithms and some gravimetric factors.

The text of the book on organic analysis (the first edition was reviewed in NATURE, **144**, 366; 1939) has not undergone much change. Some of the analytical schemes have been rewritten, while some thirty additional compounds have been included.

Both books are well got up, they are clearly written, and the text is in each case singularly free from errors. G. R. D.

THE LAWS OF NATURE*

By PROF. HERBERT DINGLE
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THE time in which Halley lived was crucial in the history of science in more than one respect, but of all its aspects none is more significant than that which shows the restoration of the possibility of cosmological studies. Astronomy before Copernicus was essentially and altogether cosmological. No heavenly body had an interest of its own; its sole function was to give a clue to the workings of the universe. But with the dawn of the idea that the universe was infinite, and with the almost simultaneous invention of the telescope, the character of the subject changed completely. The bulk of the universe—the infinite company of the stars—was removed from possible comprehension by finite minds, while the previously inscrutable members of the solar system were brought within human ken. Cosmology thereupon became impossible, and the astronomical study of single bodies began. It was Galileo and Newton who resurrected cosmology, though in a new form. The body of the universe might be inaccessible; but its soul—the universal laws of Nature—could be brought within the grasp of the human mind by the new method of "induction of principles from phenomena", which is the crown of Newton's achievement. It is Halley to whom we owe our knowledge of Newton's work, and it is therefore appropriate that in a lecture dedicated to his memory an attempt should be made to estimate the position reached after two hundred and fifty years of effort along the new lines.

Laws of Motion and Laws of Temperature

Broadly speaking, the progress of physical science since Halley lived has culminated in two comprehensive schemes of physical law. The first is typified by Newton's own laws of motion and gravitation, and is represented in our own day by the general theory of relativity and electromagnetic field theory. The second includes the laws of thermodynamics. These two sets of laws have been called 'primary' and 'secondary'. I prefer to call them 'laws of motion' and 'laws of temperature', for the former nomenclature gives a false suggestion of an order of precedence, whereas motion and temperature are, in fact, the two co-equal phenomena of universal significance that together exhaust the scope of physical inquiry. Consider any two pieces of matter at different temperatures anywhere in an otherwise empty universe. Unless our whole conception of things is wrong, one will inevitably move with respect to the other, and it will inevitably change temperature with respect to the other; and in no other respect, so far as we know, will any observable interaction occur. No known physical agency can prevent these effects. Their course may be modified by the introduction of other bodies, but by no known process can the effect of one body on the motion or temperature of another be annihilated.

It is therefore not surprising that the greatest rift in the as yet immature body of physical law should be that between laws of motion on one hand and laws of temperature on the other. Neither group of laws is, of course, as yet completely unified in itself. Gravitational and electromagnetic motions still await a final blending, and the two great laws of thermodynamics also retain a semi-independence of one another. But these divisions are comparatively slight. In the broad view, it is the separation between the domains of motion and temperature that stands out as the great unhealed breach in the unity of physical law.

Now the present laws of motion and laws of temperature exhibit a striking contrast, which in recent years has attracted considerable attention and forms the main theme of this lecture. The most obvious sign of the difference is this. Consider any possible course of events. According to the laws of motion, this might equally well have occurred in the reverse order; but according to the laws of temperature it could not have done so. There is no actual contradiction, of course, for a 'course of events' to which the laws of motion apply is a movement or set of movements, while a 'course of events' to which the laws of temperature apply is a variation of temperatures. We do not, therefore, have to choose between conflicting requirements; but nevertheless the difference is one which would scarcely have been expected in the representation of the behaviour of a single universe, and does not promise well for an eventual fusion of all scientific law into a single scheme.

An example will perhaps make the position clearer. A ball is thrown into the air. As time goes on it gets higher and moves more and more slowly. If this course of events is reversed, we have the ball getting lower and moving more and more quickly, and this is a possible state of affairs. It does, in fact, occur, for after a while the ball comes to rest, and then descends with ever-increasing speed. Next, a hot body is placed near a cold one. As time goes on, the hot body cools and the cold body gets hotter. If this course of events were reversed, we should have the hot body getting hotter and the cold body getting colder, and this is *not* a possible state of affairs. The actual process continues until the bodies come to the same temperature, and then nothing further happens; they remain at the same temperature eternally.

The mathematical expression of the two sets of laws takes account of this difference in the following way. The law of motion of the ball (in the Newtonian form, which is legitimate for this purpose) may be expressed as $F = m\,\frac{d^2s}{dt^2}$, and if we reverse the direction of time by putting $t' = -t$, we find by substitution that the law is still the same, namely, $F = m\,\frac{d^2s}{dt'^2}$. The law governing the changes of temperature of the bodies, however, is $\frac{dS}{dt} > 0$, where S is the entropy of the system; and here if we put $t' = -t$ we obtain the law $\frac{dS}{dt'} < 0$. It is the former law, and not the latter, which expresses what actually happens.

The effect of this difference on our ideas of the history of the universe is profound. It is obvious that changes are taking place, and when we can express the laws of change we can extrapolate to the distant past and the distant future. Now if a law permits only a uni-directional change, difficulties appear which are not necessary when the direction of change can be reversed, for in the latter event a *cycle* of changes may be possible, and the infinitely

* Halley Lecture delivered at Oxford on May 23.

distant past or future may be very much like the present. Some of the energy of the earth in its elliptical orbit alternates between the kinetic and potential forms, and there is no reason, so far as the laws of motion are concerned, why it should not go on doing so from eternity to eternity. But the entropy of the universe is always increasing, and that means that as we go back into the past it gets less and less, and as we go forward into the future it gets more and more. Strangely enough, it is the past and not the future that contains the greater problem, as we can see more easily if we think in terms of simple temperature exchange instead of the more recondite conception of entropy. Since the tendency is for bodies at different temperatures to come to the same temperature, we can easily visualize an ultimate future state in which the whole universe has reached a common temperature; the approach to maximum entropy is asymptotic. But as we go back into the past, we get greater and greater divergences of temperature. The hot bodies get hotter and the cold bodies colder, and this at a more and more accelerated rate until we reach a time when some bodies are infinitely hot and others infinitely cold; and we must suppose that from such a state they have taken an infinite time to come to their present relative temperatures—a conception impossible to reconcile with our experience of the heat capacity and rate of heating or cooling of bodies. It is true that simple variation of temperature does not cover the whole scope of entropy change, but essentially the same difficulty remains however we look at the matter.

The Second Law of Thermodynamics

My purpose here is to analyse the situation thus presented, in order, if possible, to elucidate the difference between the two great schemes of physical law, but before attempting a task of such magnitude, common sense suggests that we should ask whether there is any escape from the Second Law of Thermodynamics, the particular temperature law which is mainly responsible for the dilemma which faces us. Can we find a fallacy in the arguments which lead to it, or alternatively, if it is unassailable itself, can we find reasons why it is not applicable to the whole universe? We must consider this question, but I shall deal only briefly with it, for reasons which will transpire.

In the first place, then, I think that when pressed we must admit that this Law is not irrevocably established. During the brief period in which scientific studies have been pursued, we certainly find that entropy tends to increase; but it does not inevitably follow that entropy has tended to increase throughout all past time and will do so throughout all future time. Lord Kelvin's original statement was: "There is at present in the material world a universal tendency to the dissipation of mechanical energy", and I think we may take the words "at present" as an indication that he was alive to the possibility that the tendency was only temporary. Moreover, since Kelvin's time we have obtained evidence that the danger of extreme extrapolation is not a fanciful one. In our own region of space we find that bodies move towards one another, by 'gravitation' as we call it, but at very great distances they appear to move away from one another. It may equally well be that if we had 'time telescopes' by which to observe the distant ages, we might find a similar reversal in the behaviour of entropy. We certainly have no experience that makes it more legitimate for us to universalize the Second Law of Thermodynamics than it was for the nineteenth century physicists to universalize Newton's law of gravitation.

The point could be put still more strongly, for not only have we no experience of this kind, but we have evidence in the opposite direction. The general theory of relativity, as Tolman[1] has shown, leaves open the possibility that the universe might expand and contract irreversibly without ever reaching a state of maximum entropy. This possibility, beyond the knowledge of the nineteenth century physicists, comes from the reformulation of the laws of temperature made necessary by the requirement of the principle of relativity that the laws of Nature shall be independent of the standard of rest chosen for expressing them.

Again, when we look at the derivation of the Second Law itself, apart from its invariance under changes of co-ordinate systems, we find that in order to make it logically rigorous we have to insert so many provisos that its direct application to the whole universe becomes impossible. Probably the most successful attempt yet made to give precision to the law is that of Carathéodory[2]. An examination of Carathéodory's statement shows, first, that the Law refers only to a system enclosed within a boundary having at least some of the properties of material things; secondly, that since fields of force cannot be altogether obstructed by such a boundary, they must be assumed non-existent before the Law becomes capable of precise formulation; and thirdly, that the boundary must be supposed to have certain characteristics which it is not certain that matter possesses.

This last point requires a little explanation. For the rigorous statement of the Law it is necessary to distinguish unambiguously between 'heat' and 'work' as two forms of energy. This has long been a difficulty, and Carathéodory deals with it in the following way. If, when the system gains or loses energy, the boundary does not move, the whole of the energy gained or lost is to be called 'heat'. On the other hand, if the system *cannot* gain or lose energy without a movement of the boundary, the whole of the energy gained or lost is to be called 'work'. In the ordinary case, however, the energy of the system will change and the boundary will move, and in such a case we are to calculate the work and the change of energy, and the difference must be heat.

This is all very clear, but in order to carry out the programme we must know how to calculate the work and the change of energy. The former presents no difficulty, but the change of energy can be calculated only if we can find a material for the boundary such that the energy inside cannot change unless the boundary moves; in ordinary language, a boundary must be found which is a perfect non-conductor of heat. If we can find such a substance, we can perform known amounts of work on the boundary and measure the energy changes inside, confident that those changes must be equivalent to the work done; and we are then prepared to measure the energy changes when other boundaries are used. This preliminary work requires an indefinite number of experiments to ensure that, in fact, by no possible device can energy cross the boundary unless the boundary moves; but even if we ignore that practical difficulty, another of a theoretical character remains. If we have found our boundary, which is a perfect non-conductor when it is at rest, how do we know that it will remain a non-conductor when it is moving? If it does not, our whole scheme for distinguishing

between heat and work, and consequently the logical basis of our law controlling the transformation of heat into work, collapses, for whenever the boundary moves we are unable to calculate the change of energy inside and therefore unable to distinguish the passage of heat from the performance of work. We can, of course, escape from the logical difficulty by *defining* a non-conducting boundary simply as one which prohibits all change of internal energy while it remains at rest, but in that case we sacrifice the necessary connexion of the theory with the experience which it was constructed to represent. We can imagine a substance which is a non-conductor when at rest but when it begins to move exhibits all the properties of a conductor—for example, a flame placed outside it might melt ice inside—and we should still have to call such a substance a non-conductor and give the name 'work' to the heat which it allows to pass. I do not think it is the intention of Carathéodory's theory to be logically invulnerable at the cost of being no longer an account of the laws of thermodynamics.

The result of all this is, then, that unless the universe has a boundary which necessarily possesses some of the properties of matter and necessarily lacks others which some forms of matter, so far as we know, may very well possess, and unless we can exclude the possibility of fields of force which can penetrate the boundary, we cannot certainly apply the Second Law of Thermodynamics to the universe as a whole. It is interesting to recall that in the early days of the doctrine of the degradation of energy, Rankine[3] sought to evade its application to the universe by postulating the existence of a boundary, whereas now it is the non-existence of a boundary that we invoke to the same end. Rankine's arguments, however, have no weight in the light of present knowledge.

For various reasons, then, we must reject the claim, only too often made, that the universe 'must inevitably' have begun with a bang and be destined to end with a whimper. But this, after all, does not carry us very far. After disposing of exaggerated conclusions, we have still to reach balanced and temperate ones, and none of the considerations just advanced weakens the force of the Law as expressing present tendencies. Over the whole range of space and time that we can cover, we have always found its demands inexorably imposed and met. The fact that we cannot conclusively deduce its universality gives us no ground for denying that it might, nevertheless, be universal, and it is wise to face that possibility and see how, if at all, we can reconcile it with the greater range of possibilities suggested by the laws of motion.

I should say, however, that I cannot accept the view, which has found favour in some quarters, that the operation of the Second Law of Thermodynamics constitutes scientific evidence for a supernatural creation at a particular time in a not infinitely distant past. Such a view would indeed dispose of our problem, but not to my mind in a legitimate way. Our object in science is to give a natural, rational account of things, not to invoke inscrutable, *ad hoc* powers to explain them away. No one would admit the validity of accounting separately for every observation we make as a supernatural result of the divine will. Such an explanation would be rejected, not necessarily because it was felt to be 'untrue' but because it would be irrelevant. Our aim is to relate each occurrence to others, thus forming a rational correlation of experiences, and an event is not released from inclusion in the scheme of correlation because it happened a long time ago. If, then, we postulate a supernatural creation on scientific grounds, it can only be because we have got into a difficulty from which we can see no escape. The proper course in that case is to try again or else admit that we are beaten. It is not fair to insist on a rational explanation of easy things and fall back on supernaturalism for the difficult ones. If we bring in supernatural agencies at one point we may as well bring them in at all points, and save ourselves the trouble of constructing a trivial man-made rational order.

Experience and Terms of Expression of Experience

The problem before us, then, is this. The present laws of motion and laws of temperature show a non-conformity which is scarcely compatible with our expectations or with our hope that we shall one day arrive at a single comprehensive scheme of physical law; and, further, the laws of temperature, when extrapolated towards the past, lead to a state of the universe which we cannot regard as physically possible. To deal with such a problem we must understand clearly the scope and character of physical laws.

Our aim in science, let me repeat, is to give a rationally connected account of our experience. In order to do this, we must choose *terms of expression* which will enable us to relate together experiences which are in themselves distinct and independent. The experiences are unalterable: they are our primary data, and it is the fundamental canon of science that we accept them unquestioningly. Of course, in the physical sciences, we impose certain tests to distinguish those experiences which are fit subject-matter for our purpose from those which we regard as 'illusions' or 'hallucinations' or 'errors of observation', and hand over to the psychologist, but that is merely a process of selection, not of rejection or modification. The terms of expression which we choose for describing and correlating our experiences, however, are at our choice, and we choose those which enable us to give the most comprehensive rationally connected account of experience. Certain terms of expression are so well established that we have difficulty in recognizing that they are at bottom arbitrarily chosen and not the unique inevitable verbal forms which experience must assume, and the first task that faces anyone who wants to obtain a fundamental understanding of science is to distinguish inviolable experience from deposable terms of expression of experience. The latter, of course, form the language in which laws of Nature are expressed, and their term of office, so to speak, sets an ultimate limit to that of the laws.

Let us take a few examples, to make the difference clear. With a certain arrangement of optical apparatus we observe an alternation of dark and bright bands on a screen. That is an experience. We sometimes describe it as an 'interference pattern', and when we do that we imply a system of waves of light which, when they intersect, can reinforce or neutralize one another. In these terms we can get a consistent, and for many purposes altogether satisfactory, way of describing the experience; but it is not a necessary way, although in the last century many physicists would have thought it to be so. We can also think of a swarm of small particles of light, and in those terms we say the swarm is dense in the bright bands while there are few particles or none in the dark

bands. That also gives a consistent, and for certain purposes satisfactory, description of the experience. We can adopt which description we please so far as Nature is concerned, and our choice will ultimately be determined by the power of the respective terms of expression to afford a description of the widest range of experience.

The fundamental arbitrariness of the choice here is now fairly familiar, but there are other phenomena in which it is less so and in which we may not be able to recognize it without some difficulty. Motion affords a good example. What we call motion is an experience, but the expression of motion as a change of position with time is an arbitrary one—extremely useful, of course, and not lightly to be discarded, but still not essential. An occupant of a smoothly running car can determine if he is at rest or moving not by observing any process of change of position with time, but by noting whether the number opposite the stationary pointer of his speedometer is zero or something else, and he can, if he wishes, describe his experiences in terms of his pointer readings without reference at all to the space and time measurements in terms of which an external observer would probably describe them. The speedometer language, in fact, is, in principle, that in which we originally describe most of the motions we observe in the universe, for the spectrum, which informs us whether a star is approaching or receding, is a kind of speedometer in which the displacement of the lines corresponds to that of the pointer. We usually translate this direct expression of the movement into a statement in terms of space and time, but that is merely for convenience; it is not a necessity.

Again, the measure numbers we assign to movements are likewise arbitrary. It is now common knowledge that there is a limiting velocity possible for bodies, namely, a velocity of about 3×10^{10} cm. a second. There is an inviolable experience hidden in this statement, but it is not in that part of it which gives a finite number to the limiting velocity; that is a characteristic of the arbitrary choice of space and time measurements for the expression of motion. If we choose the Doppler effect instead, and measure velocities in terms of the difference of wavelength of spectrum lines, we find that velocities of approach have a finite limit but velocities of recession may have any value up to infinity. Other, equally valid, terms of expression are possible in which *all* velocities may increase up to infinity. What we experience is quite unaltered by the terms of expression we choose, but any 'law of Nature' which requires that bodies at high speeds suffer some intrinsic change of character which makes it inherently difficult for them to move faster is no law of Nature at all, but an illegitimate statement in a language the possibilities of which exceed its lawful scope.

Far-reaching deductions are often made from the supposed fundamental distinction between 'things' and 'processes', the former being static and the latter dynamic. Dialectical materialists make much of this, and from Zeno and Heraclitus onwards, schools of philosophy have been divided into those who attempt to get beneath change to a constant substratum and those who find in change itself the essential characteristic of existence. The fact is, however, that whether a phenomenon is changing or static depends on the terms in which we choose to express it. If we express motion in terms of space and time, we must call it a changing process, and in order to discover whether a body is moving or not, a finite time, however short, must elapse, for we must compare the positions of the body at two distinct instants. On the other hand, if we express motion in terms of the Doppler effect, no change at all is involved. The static position of the spectrum line is the criterion; we do not require two observations at two separate instants, but one single instantaneous observation alone. I have assumed here that the velocity, whether zero or not, is constant, but the same principle holds if it is not. In that case, if we wish to regard the phenomenon as a static one, we must choose an instantaneous criterion of acceleration instead of velocity, and this we find in force. Take the motion of a planet round the sun. We can describe this by stating the successive positions of the planet in time, or the successive velocities of the planet in time, and each of these descriptions shows it as a changing phenomenon. But if we state the gravitational field, and give values of the position and velocity of the planet merely at one instant, we can describe the whole motion in completely static terms, and see the phenomenon as an example of eternal quiescence.

What is true of motion is true also of other things. A lamp burns steadily. In terms of its candle-power it is an example of steadfast constancy; in terms of radiation of energy to space it is engaged in the most rapid and most irrevocable waste known to Nature. Both modes of description are, of course, perfectly legitimate, and it is exactly the same experience that they describe so differently. Similarly, a body at constant temperature may be regarded either as an inert mass or as engaged in a constant interchange of energy with the whole universe. We may, and on occasion do, use both descriptions.

Problems Arising from Terms of Expression

Examples could be multiplied indefinitely, but probably enough has been said to make it clear that the distinction between experience and terms of expression of experience is an important and often a very subtle one, and that problems which seem to be fundamental may actually belong only to the arbitrary terms of expression employed. Such problems are not solved when the terms of expression are changed; they simply become meaningless and disappear, for they have no basis in experience. An example will illustrate how this occurs.

One of the earliest problems presented to the philosophic mind was that of accounting for the movements of the heavenly bodies. The motions themselves were facts of experience. For their description, however, certain terms were necessary; and the early astronomers made the assumption that the stars and planets were carried round the earth on spheres. The spheres had each a simple circular movement, but they could communicate their movements to one another, and the path of the heavenly body showed the resultant movement, from which the separate spherical revolutions had to be extracted by analysis. When we consider that the stars at least, numbering some thousands, all appeared to revolve in precisely the same period round an obviously stationary earth, we can easily believe that the existence of the spheres must have seemed a necessity; but in the light of present knowledge we can see that it was not so, but was a postulate chosen for the purpose of bringing order into the observed motions.

It did so very successfully. Most of the observed motions could be described to a high degree of approximation in terms of simple circular motions, but

certain unanswered questions remained. What were the spheres made of? How were their motions maintained and communicated to one another? Was the concave sphere of one planet coincident with the convex sphere of the next, or was there a space between them? And so on. These were fundamental cosmological questions, and no way of answering them suggested itself.

In the course of time a revolution occurred. The spheres were abandoned, the sun and stars reduced to rest, and the earth and planets conceived as revolving round the sun in elliptical orbits under the influence of a force of gravitation falling off as the square of the distance from the sun in all directions. The fundamental experiences—the observed movements of the heavenly bodies—were now describable equally well, and even better, but in totally different terms. Instead of revolving spheres, there was gravitational force—a postulate quite foreign to the earlier scheme. At the same time, the old unsolved problems simply disappeared. It was meaningless to ask the size or composition of the spheres, or the cause of their motions, because they were not actual existences but discarded terms of expression. On the other hand, however, new problems arose of which the ancient astronomy knew nothing. What were the physical properties of a medium which could take the enormous strain of holding the planets in their orbits and yet offer no resistance to their motions? What was the velocity of the solar system through this medium? Such questions as these now stood in the forefront of universal problems and appeared as the fundamental enigmas of cosmology; but, despite the concentrated attention of the greatest minds, they received no answer.

Gravitational force has now gone the way of the spheres, and new terms of expression have arisen. We no longer think of a planet as chained to a distant sun. It moves quite freely along its path, taking the easiest course in a 'space-time' having a 'curvature' which distinguishes one direction of motion from another. Again the same fundamental experiences are described with a still further improvement, and again the old unsolved problems vanish. There is no force to cause a strain between the earth and the sun, and it is meaningless to ask for the physical properties of a medium created to sustain one, or for the velocity of the solar system through such a medium. These questions belonged to the discarded terms of expression of celestial motions, not to the phenomena of the motions themselves. And, with the new outlook, just as with the older ones, difficulties are associated. One of them, for example, is the non-conformity of the petrified space-like universe which it contemplates with the dynamic universe shown by the laws of temperature.

Source of Incompatibility of Motion and Temperature Laws

As I have put the matter, the suggestion is irresistible that we should look not for the solution of this problem through an examination of the details of current theories, but for its disappearance by a change in the terms of expression of the phenomena. That is indeed what I am going to propose, but before doing so I would like to say that I fully realize that such a course should be undertaken only in the last extremity. When a system of concepts has proved to be applicable over so wide a range as that covered by current physical concepts, it needs a critical and otherwise insuperable impasse to justify even the thought of its displacement. Most scientific problems are relatively so superficial that anything so drastic as a change in the basic terms of expression would be beyond reason. When Uranus was found to move in a puzzling way, Adams and Leverrier did not begin to reform the foundations of mechanics. Rather than do that, they were prepared to call a new world into existence to redress the balance of the old, and they did so within the framework of current mechanical theory. This, of course, was the proper procedure, and, as everyone knows, it was completely successful. Indeed, so accustomed are scientific men to dealing with obstacles which can be removed in this way that they show great and usually justifiable reluctance even to entertain the idea of changing their terms of expression. Nevertheless, there are circumstances in which it is necessary to do so, particularly when one is dealing with fundamental questions involving extended extrapolation. That, I think, is the situation here. Of all physical questions, there could be none more fundamental and comprehensive than the one which we are now discussing; and the same sense of proportion which should make us regard old and tried terms of expression as binding in ordinary matters should induce us to question them when the problem goes to the root of things.

Let us, then, try to strip from our statement of the laws of motion and temperature those parts which belong to the mode of expression, and see if the discordance remains in the character of the phenomena themselves. There is a limit beyond which it is impracticable—at any rate, to begin with—to carry this purifying process, because if we pursued it to the bitter end we should find ourselves left with nothing but bare sense-data inexpressible except by isolated *ad hoc* words between which there would be no possibility of forming even a connected sentence. Prof. E. A. Milne has rightly insisted that, in the last resort, our scale of time measurement—the convention which decides whether a period of time is equal or unequal to another—is arbitrary, and that we might have chosen a very different one. I would go further and say that, difficult as it may be to acknowledge, even the *order* of our experiences in time is, in the last resort, imposed rationally, and is not an inviolable element of the experiences themselves. But we need not, unless ultimately compelled to do so, go to the last extremity. It may be that the source of our present difficulty lies at a higher level of rational thought than that which comes next to bare experience; and if so, it would be as foolish to go at once to rock bottom as it would be to strip ourselves naked to repair a defect in one of the outer layers of clothing. We will therefore accept our sense data, in the order in which we are accustomed to place them, but freed from all entanglement in formally expressed laws of Nature. For convenience I shall speak of this very primitively rationalized experience as 'bare experience'. We will see if in such bare experience we still find a divergence between the phenomena of motion and those of temperature.

We see at once that we do not; the phenomena of motion, equally with those of temperature, show a one-way tendency. Corresponding to the fact that bodies tend to come to a common temperature and not to differ in temperature as much as possible, we have the fact that bodies tend to move together and not to separate from one another. This is the familiar phenomenon of gravitation. In speaking of it as a fact of experience I ignore, of course, the apparent

recession of the extra-galactic nebulæ, partly because, as a bare fact of experience, that is not a motion at all but a characteristic of spectrum lines, only interpreted as a motion when we have accepted certain rather detailed terms of expression of experience; and even then, as the present disagreement among astronomers shows, not inevitably so interpreted. But I ignore it also because, even if it is taken into account, it does not alter the fact that motions show a one-way tendency, but simply indicates that the tendency is in one direction in some circumstances and in the opposite one in others; it does not make the phenomenon of motion indifferent to the direction of time as the present *laws* of motion do. The indications of bare experience can be represented by the simple idealized situation I pictured earlier. Place two bodies at different points in an otherwise empty universe. They will move in one direction, and not the opposite one, with respect to one another; and they will tend towards the same and not more widely divergent temperatures.

This common one-wayness is, in fact, shown in almost all our theories of cosmic evolution, characterizing the motions as well as the temperature phenomena of the universe. Laplace's nebular hypothesis, for example, depicted a primitive diffuse nebula evolving gradually into a complex organization of many bodies, and, quite apart from the laws of temperature, it provided no possibility of the course of events occurring in the reverse direction. Generalizing such ideas, Herbert Spencer's famous definition of evolution, concerned with matter and motion alone, included only a one-way process from the homogeneous to the heterogeneous. Even in detailed phenomena, such as the direction of revolution of the planets round the sun, we recognize that, whatever the laws of motion may allow, the planets do, in fact, go in a particular direction, and we do not regard it as possible that they will change to the opposite one. The actual, as contrasted with the possible, course of events is uni-directional. Somewhere, in building up our structure of laws of motion from the observed facts, we have introduced a liberty of movement which is not in fact taken advantage of, whereas in building up our structure of laws of temperature from the observed facts we have introduced no such liberty. The difference lies in our terms of expression of experience, and not in bare experience itself, and we must look for it there.

[1] "Relativity, Thermodynamics and Cosmology" (Oxford University Press, 1934).

[2] *Math. Ann.*, **67**, 355 (1909). The theory has been expounded very clearly by M. Born in three articles in *Phys. Z.*, **22** (1921).

[3] *Phil. Mag.*, iv, **4**, 358 (1852).

(*To be continued.*)

SOIL STERILIZATION

IN horticulture, as in other industries, the War has focused attention on ways and means which before 1939 had not received the notice they deserved. Among them is soil sterilization as a factor in food production. How to produce the greatest amount of good food has become an urgent problem for Great Britain, and there is little reason for believing that this need will be much less pressing for some years to come. To produce the quantity and quality of food we require, five things are necessary. Site, soil and cultivation must be suitable, the choice of variety must be correct and pests and diseases must be controlled. All these are important, but not every one has received proper consideration. Pests and diseases, for example, not only cause serious losses in food production, but they also waste time, labour and materials. Thus, by employing measures for the control of pests and diseases, a higher yield per plant can be obtained with greater economy than by merely increasing the number of plants.

The more intensive the system of cropping, the more likely is it that disorders will occur and the more necessary it becomes to prevent their arising. It is not surprising, therefore, to find that the demands of war have focused attention on problems of soil hygiene in the most intensive system of all, the production of crops under glass. Growers have found that yields fall off and soil pests and diseases assume serious proportions unless the soil is partially sterilized by the periodic use of heat or chemicals.

The sterilization of soils used under glass is necessary for either of two reasons. In the case of pot plants, for which virgin soil is almost always used, sterilization kills the pests and diseases normally existing in the soil. In the case of glasshouse borders which have carried the same main crop year after year and become 'soil-sick', partly through the accumulation of various pathogenic organisms and partly due to biological and chemical unbalance, sterilization is necessary to restore the resulting loss in fertility.

Cleaning up the soil by sterilization is fast becoming an indispensable routine practice under glass, and to meet the situation war agricultural executive committees have recently added to their machinery pools, apparatus for the steam sterilization of glasshouse soils. In cases where steam sterilization is not practicable chemical sterilizing agents, such as formaldehyde, are being increasingly used. Thus, the time is ripe for consideration of the methods and problems of soil sterilization, and with this in view a joint meeting for the discussion of the subject was held on April 19, between the Society of Chemical Industry (Microbiological Panel of the Food Group and the Agricultural Group) and the Association of Applied Biologists.

Dr. W. F. Bewley discussed the general aspects of the subject. Soil sickness and the depredations of eelworms were problems which, in the early years of this century, faced the glasshouse growers in the Lea Valley and elsewhere. They found by empirical methods that if the temperature of sick or infested soil was raised to 100° C. for a sufficient length of time, the harmful organisms were killed and fertility restored. The commonest method employed for glasshouse borders was to force steam into the soil to a depth of 12 in. or more by means of perforated pipes or an inverted tray. At first, pressures of 30–40 lb. per square inch were used, and steaming was carried on for 1–2 hr.; to-day pressures of 80 lb. or more are employed and steaming is for 20–30 min. only. For small quantities of soil, baking was commonly practised in earlier years. With this method, however, patchy heating and 'over-sterilization' are dangers, although if the soil is moderately wetted before it is baked the danger is reduced. Before use, baked soil must be left 4–6 weeks "to recover".

Low-pressure steaming is a method rapidly coming into favour. The soil is put into a perforated container which fits on to a trough of boiling water, the steam from which penetrates upwards through the soil. Electric sterilizers, in which the soil is heated either by the passage of the current through

the soil itself, or by heaters, have also been developed. Plant growth is luxuriant following soil sterilization, and it is now clear that the fertility of glasshouse borders can be maintained over long periods if the soil is sterilized every third or fourth year and manure added from time to time to ensure good organic content and texture. As Dr. Bewley pointed out, however, although sterilization of a poor soil makes it temporarily more fertile, sterilization alone cannot change a poor soil into a rich one.

At the same time that soil sterilization methods were being developed by practical growers, critical investigations were started at the Woburn and Rothamsted Experimental Stations (1908–12). It was found that (1) weeds, weed seeds, and most soil organisms were killed at 60° C.; (2) the nitrifying bacteria and Protozoa were also killed at 60°, but the ammonifying bacteria survived 100° and in the absence of their enemies, the Protozoa, rapidly repopulated the soil; (3) heating increased the amount of soluble organic and nitrogenous matter in the soil and there was a temporary excess of ammonia; (4) seedling growth was not infrequently retarded, presumably owing to the increase in the amount of soluble organic compounds, with a consequent excess production of such substances as ammonia; (5) retardation was greatest when rich soils were heated, but no direct correlation could be established between soil fertility and the degree of retardation. It was concluded that "retardation need not cause any anxiety".

From 1920 onwards, high-pressure steam won increasing favour for the sterilization of glasshouse borders in which tomatoes and cucumbers were grown. Curiously enough it did not become popular among growers who raised pot plants from seed, and so late as 1935 very few 'mixed nurseries' regularly steamed their soil. The reason for this reluctance became apparent when, in an attempt to combat soil-borne disease, sterilized soil was first used on a large scale at the John Innes Horticultural Institution. The results were disastrous in the case of one or two species and harmful in varying degrees to a number of others. At the worst, seeds did not even germinate, while commonly seedling growth was much retarded. Mr. W. J. C. Lawrence described the investigations which led to the unravelling of the complex of factors resulting in this sterilization 'check'. Clay and sand did not react to heating; but humus gave a marked reaction. If lime was added to humus, or to a soil containing humus, before it was heated, the reaction was greater still. Prolonged heating also led to retardation. Most important of all, it was found that the addition of water-soluble phosphate (for example, superphosphate) to soil after heating counteracted the 'check' to seedling growth. From these results, and from the appearance of the plants, it was clear that the application of heat to humus resulted in its decomposition and the production of available nitrogenous compounds which, in excess, were too rich a diet for many seedlings. For example, *Primula malacoides* proved to be highly sensitive to soil sterilization by heating, whereas tomato and cucumber were among the most tolerant. In a few vigorously growing species the excess nitrogenous compounds actually accelerated growth even while the plant was still quite young.

It is now clear why steam sterilization, so widely used for the treatment of glasshouse borders, had not become popular in mixed nurseries for the raising of seedlings. The particular plants used in the experiments at Rothamsted were relatively insensitive to the effects of heating, as are the tomatoes, cucumbers and lettuces grown in glasshouse borders; and retardation or other effects were rarely so marked as to be obvious in the absence of controls. Thus, there was no *prima facie* evidence that extra precautions would have to be taken for the seedlings of other species. The variable results from sterilizing different soils could also be explained, the precise outcome depending in the main on the relative proportions of humus, lime and soluble phosphate present. Soils with relatively high humus and lime and low soluble phosphate contents give the greatest retardation when sterilized. Soils with relatively low humus and lime and high soluble phosphate contents give the least retardation. In the light of these findings an improved technique of steam sterilization for seed and potting composts was worked out at the John Innes Institution, and the benefits of soil sterilization are now available for the vast majority of plant species, without any of the various evil consequences.

The practical requirements of soil sterilization by heat can now be stated in precise terms. (i) In glasshouse borders, pests and diseases occur at a considerable depth, therefore thoroughness of heating is the vital factor. The production of nitrogenous compounds in excess is not usually of serious consequence since tomatoes and cucumbers are not planted in the borders until some weeks after sterilization, and even then not as seedlings but as established plants. (ii) For seedlings and pot plants, the vital necessity is to keep down the production of nitrogenous compounds. This can be done by the efficient use of sterilizing bins in which a relatively small expenditure of heat is adequate for the thorough sterilization of the soil. The addition of superphosphate to the soil after it has been sterilized then partially immobilizes any nitrogen still in excess.

High-pressure steam sterilization has disadvantages for the small grower, of whom there are many. The locomotive boiler and steam tubing employed involve a large capital expenditure, and the apparatus is cumbersome to use. Obviously, it was worth ascertaining whether chemical substances in solution would be as efficient as steam but more convenient, especially for the small grower. Investigations were made first at Rothamsted and later at Cheshunt Experimental Stations. No chemical sterilizer proved to be as efficient all round as steam. Wetting and penetration of the soil present difficulties, and in general the action of the chemical sterilizers is more selective than steam. Thus formaldehyde, the best of the chemical agents, restores fertility well, is a good fungicide, but it is not very lethal to soil pests. Cresylic acid, on the other hand, is efficient against pests but is not very lethal to soil-borne diseases and does not restore fertility so well as formaldehyde. If the effectiveness of steam in increasing crop weight in the tomato is taken as 100, then the figures for formaldehyde and cresylic acid may be reckoned to be less than 90 and 80 respectively. Further, whereas steaming need be done only once in every three or four years to maintain soil conditions, the chemical sterilizers must be applied every year. Improvements in the efficiency of the chemical sterilizers may be expected, however, and Mr. A. H. Dodd described the characteristics of some of the newer substances of the high-boiling phenol type.

Since the Woburn and Rothamsted experiments, practically no fundamental research has been done in

Great Britain on soil sterilization; progress has resulted from methods and experiments of an empirical nature. A new lead has now been given by Rothamsted. Mr. H. Lees and Dr. J. H. Quastel described an ingenious method whereby studies can be made of the effects of certain chemical substances on the metabolic activity of the soil microflora. The 'perfusion unit' employed gives reproducible results, and by its aid it has been established, for example, that potassium chlorate has a selective effect on the bacteria concerned in nitrification. Oxidation of ammonia to nitrite proceeds normally; but oxidation of nitrite to nitrate is inhibited. Further, it has been possible to show that the non-production of nitrate is not a direct effect of the potassium chlorate, but results from the accumulation of nitrite. Lees and Quastel were also able to show that chlorate toxicity is greatly reduced by the addition of nitrate to the soil. Vanadium has a similar effect to chlorate, but smaller; an effect which is general instead of specific. Lees and Quastel's method seems to offer excellent possibilities for further attacks on the problem of what happens to soil when it is heated.

What then is the position of soil sterilization in horticulture to-day? By trial and error methods it has been discovered how to secure the greatest benefits with the slightest risk. Too little fundamental research has been done. For example, it is not known whether excess ammonia is the only product of heating which retards seedling growth; indeed it is not even known whether ammonia is the chief agent concerned in retardation. The action of soluble phosphate on sterilized soil, the chemical effects of electricity in electric sterilizers, the wetting and penetration properties of chemical sterilizers, are other examples of problems awaiting investigation. On the applied side much remains to be done in the design of steam and electric sterilizing apparatus, and there is no reason why what now appears to be a remote possibility, automatic and ultra-rapid sterilization of soil on the moving belt system, should not be achieved under commercial conditions. The use of heavy gases, such as chloropicrin, is another field which awaits the attention of the tool designer as much as the soil chemist.

The main conclusions are clear. Under present and anticipated economic conditions in Britain, horticulture cannot go back to the days when infested and sick soil was tolerated in food production. Neither can it go forward, so far as soil sterilization is concerned, without the co-ordination of fundamental and applied research.

W. J. C. L.

OBITUARIES

Mr. J. R. Norman

THE British Museum (Natural History) has suffered a great loss by the death at Tring at the premature age of forty-five and after a long illness of Mr. J. R. Norman, deputy keeper in the Department of Zoology.

Norman was born in London in 1898, and educated at St. Paul's School. His career was then interrupted by military service in the War of 1914–18. He was invalided out of the army in 1918 and resumed his education at the Imperial College of Science and Technology under the late Prof. E. W. MacBride. In 1921 he was appointed an assistant keeper in the British Museum and in 1942 was promoted to a deputy keepership. During the period of the present War he was entrusted with the charge of the branch of the British Museum at Tring.

Norman, after the retirement of the late Dr. Tate Regan, had the care of the fishes, and in this branch of zoology became the leading authority in Great Britain. He was the author of an admirable book, "The History of Fishes", and of numerous technical papers on the subject. Of these the majority deal with questions of taxonomy and morphology over a wide range of fishes and include a monograph on the Heterosomata (the flat fishes) which was published by the Trustees of the Museum. He also described collections of fishes resulting from the "Discovery", "Antarctica", "John Murray" and the "Cambridge Suez Canal" expeditions. His last work, which is on the verge of publication, is a biography of the late Dr. Charles Davies Sherborn of "Index Animalium" fame.

The rearrangement of the Fish Gallery at South Kensington and the guide book to it was his own work, and during his appointment to the charge of the Tring Museum he organized the exhibition there with great success; here he showed the width of his zoological knowledge of birds and mammals in addition to his own special subject. Both places will serve as monuments to his skill and understanding.

Norman was a fellow of the Linnean Society and of the Zoological Society, of which at the time of his death he was a vice-president.

As a colleague he was admirable from every point of view, full of enthusiasm and fertile of ideas for the good of the Museum in general. His kindly disposition made him liberal of help to others.

Owing to the complaint contracted during his military service in the War of 1914–18 Norman was never strong, but the frequent occurrence of ill-health at no time rendered him impatient nor diminished his sense of humour. He did his work and did it well and never complained. He leaves a widow and two children to whom all sympathy is due.

C. FORSTER-COOPER.

WE regret to announce the following deaths:

Dr. H. A. Buehler, geologist and director of the State Bureau of Geology and Mines, Missouri, on March 14, aged sixty-seven.

Dr. J. S. Bury, physician to the Manchester Royal Infirmary and a past-president of the Manchester Pathological Society and the Manchester Medical Society, on June 10, aged ninety-two.

Prof. J. Shaw Dunn, professor of pathology in the University of Glasgow, on June 10, aged sixty-one.

Dr. Robert A. Hatcher, emeritus professor of pharmacology and materia medica at Cornell University Medical College, on April 1, aged seventy-six.

Mr. E. Hatschek, the distinguished authority on colloid chemistry, on June 4, aged seventy-five.

Prof. Edward B. Mathews, emeritus professor of mineralogy and petrography at Johns Hopkins University, on February 4, aged seventy-four.

Prof. W. E. Tottingham, associate professor of agricultural chemistry in the University of Wisconsin, president in 1931 of the American Society of Plant Physiologists, on March 2, aged sixty-two.

Sir Cuthbert Wallace, Bart., K.C.M.G., C.B., president during 1935–38 of the Royal College of Surgeons of England, on May 24.

NEWS and VIEWS

King's Birthday Honours

The following names of scientific men and others associated with scientific work appear in the King's Birthday honours list:

Order of Merit: Sir Henry Dale, president of the Royal Society.

K.C.B.: Sir Walter Moberly, chairman of the University Grants Committee.

Knights Bachelor: Mr. E. Rock Carling, consultant adviser in surgery and adviser on casualty services to Ministries of Health and Home Security; Mr. A. W. Clapham, secretary of the Royal Commission on Historical Monuments, and lately president of the Royal Society of Antiquaries; Dr. W. A. Daley, school medical officer, L.C.C.; Mr. W. Ll. Davies, librarian of the National Library of Wales; Prof. Alexander Fleming, professor of bacteriology in the University of London, discoverer of penicillin; Prof. H. W. Florey, professor of pathology in the University of Oxford, for services in the development of penicillin; Dr. P. Hartley, director of biological standards, National Institute for Medical Research; Dr. H. S. Houldsworth, Controller-General, Ministry of Fuel and Power; Dr. M. F. Lindley, Comptroller-General of the Patent Office; Prof. G. I. Taylor, Yarrow research professor of the Royal Society.

C.B.E.: Prof. J. D. Cockcroft, chief superintendent, Air Defence Research and Development Establishment, Ministry of Supply; Major K. Gordon, joint managing director, I.C.I. (Fertilizer and Synthetic Products), Ltd.; Mr. J. B. Grant, director of the All-India Institute of Hygiene and Public Health, Calcutta; Mr. T. C. Keeley, for services to Government scientific research and training; Capt. R. N. Liptrot, assistant director of research and development, Ministry of Aircraft Production; Dr. B. H. C. Matthews, head of the R.A.F. Physiological Laboratory; Colonel L. Newcombe, principal executive officer and librarian, National Central Library; Mr. E. F. Relf, superintendent of the Aerodynamics Department, National Physical Laboratory; Prof. W. P. Yetts, professor of Chinese art and archæology in the University of London.

C.B.: Mr. R. R. Enfield, principal assistant secretary, Ministry of Agriculture and Fisheries; Prof. L. C. Robbins, director of the Economic Section, War Cabinet Secretariat.

C.M.G.: Mr. C. W. M. Cox, adviser on education to the Secretary of State for the Colonies; Mr. J. B. Hutchinson, geneticist, Cotton Research Station, Trinidad, and cotton adviser to the Comptroller for Development and Welfare, West Indies; Mr. R. S. Mackilligan, inspector of mines and petroleum technologist, Trinidad; Mr. R. W. R. Miller, director of agriculture and sisal controller, Tanganyika Territory.

C.I.E.: Sukumar Basu, secretary to the Department of Agriculture, Bengal; Mr. G. R. Henniker-Gotley, conservator of forests, North-West Frontier Province, India.

Horace Darwin Fund of the Royal Society

The Royal Society has been offered £2,000 by an anonymous donor to establish a fund for the provision of apparatus and materials for restoring the equipment of laboratories and institutions for scientific research in enemy-occupied territory. It has been stipulated that the fund be associated with the memory of the late Sir Horace Darwin, who did so much to promote the development and use of instruments in research and its applications. The Royal Society has accepted the gift, and has agreed to create a "Horace Darwin Fund". It has been a part of German policy to destroy scientific institutions in invaded countries, after looting apparatus or other equipment likely to be of use, and it may be expected that great difficulty will be experienced in re-starting the scientific life of these unfortunate lands. The help which can be given through the provision of instruments and equipment will be an important contribution to the solution of this difficult problem, and will forge another link in the chain of international collaboration. Contributions should be sent to the Treasurer, Royal Society, Burlington House, Piccadilly, London, W.1.

Research Fellowships in the Medical Sciences at Sheffield

The Council of the University of Sheffield has received a notification from Mr. J. G. Graves, of the intention of the J. G. Graves Trustees to endow research fellowships in medical sciences at the University; the Trustees have transferred to the University £25,000 for this purpose. Alderman Graves is already known for his munificent gifts to Sheffield; he had already contributed handsomely to the building funds of the University and in particular he was the donor of the University Union building, completed in 1936, which provided, for the first time under one roof and on an adequate scale, the facilities for that corporate social life of the students which is so essential a part of a university education. By their present gift, the Graves Trustees have placed the University still further in their debt. For many years the University has been an active centre of medical research, and the achievements of Sir Edward and Lady Mellanby and of H. W. Florey are but outstanding examples from a continuous stream of work directed to the understanding and alleviation of man's bodily ills. The gift will allow the appointment, as soon as circumstances permit, of young workers to fellowships where each will, for a substantial period, devote all his attention to the investigation of some important problem in medical science in an atmosphere already most favourable to such endeavour. The gift not only enriches the scientific life of the Medical School and the University; it may well be expected that in time to come it will bear fruit in medical practice of lasting benefit to mankind as a whole.

Society of Instrument Technology

A Society, with the above title, has been formed for those interested in the design, manufacture, use and maintenance of scientific instruments. Its general purpose is the advancement of instrument technology by the dissemination and co-ordination of information relating to the design, application and maintenance of instruments. It will also provide opportunities for discussion, particularly between the designers and manufacturers on one side, and the users on the other. Among other objects of the Society are the technical education of those who wish to enter, or are already in, the industry and dealing with instrument research, design, manufacture or use; encouragement of research into problems relating to instrument technology; standardization of instruments and accessories by collaboration between manufacturers and users; and the status and prestige of those employed in the industry.

Members of Council and officers of the Society are as follow : *President*, Sir George Thomson ; *Members of Council*, Dr. W. J. Clark, Mr. R. E. Iggledon, Mr. G. H. Farrington, Mr. F. C. Knowles, Dr. W. F. Higgins, Mr. D. A. Oliver, Mr. W. B. Wright, Dr. H. S. Gregory, Mr. C. R. Sams, Dr. E. Griffiths, Mr. E. B. Moss and Prof. F. Debenham ; *Hon. Treasurer*, Dr. H. B. Cronshaw ; *Hon. Secretary*, Mr. L. B. Lambert, 55 Tudor Gardens, London, W.3. It is intended to call a general meeting, probably in the early autumn, at which the constitution and rules, as recommended by the Council, will be submitted for the formal approval of intending members.

Supply and Allocation of Raw Materials

THE second annual report of the Combined Raw Materials Board, to January 26, 1944 (London: H.M. Stationery Office, 2*d.* net), states that the policy of the Board during 1943 has been to concentrate on those materials which were vital to the war effort, were actually or potentially scarce during 1942, and continued to demand action on a combined basis for their effective utilization. The principal metals, and the alloying metals, tungsten, cobalt, molybdenum, vanadium, chromium and manganese, have remained under continuous supervision, while supplies of rubber and hard fibres for rope-making remained critical and demanded continual attention and drastic action. Electrical and instrument programmes in connexion with aircraft and military equipment gave rise to great anxiety regarding mica and especially certain critical grades of it ; the same problem of securing an adequate supply and the proper distribution of critical grades brought asbestos within the scope of the Board. The liberation of Madagascar late in 1942 led to a co-ordinated review of supplies of graphite and their allocation, and the loss of practically all supplies of silk at the time when the joint parachute programmes were making heavy calls brought the alternative synthetic fibre 'Nylon' under the Board's supervision. The output of adequate supplies of balsa wood had to be assured to make possible the production of Mosquito aircraft, while balata, bismuth, bristles, mercury, rotenone, pyrethrum and hides all came or were maintained under review during the year.

The nature of the Board's allocations has varied according to the complexity and acuteness of its problems. To ensure the maximum desired or practicable production of a material, and also that each country uses scarce materials economically, the Board works in the closest contact with the operating departments. Problems of shipping and transport have been of prime importance, and certain problems have been treated on an area basis. Combined committees for copper and steel which had been set up in association with the Combined Production and Resources Board at the end of 1942 were supplemented during 1943 by similar committees for aluminium and magnesium, coal, footwear, leather and hides, and pulp and paper. The overall raw materials position did not change radically during 1943 ; but serious new shortages developed in hides and wood pulp, and a Joint Hide Control Office was set up in Washington to co-ordinate the procurement of overseas hides. The overall stringency is likely to continue indefinitely and well into the post-war period, while a combined committee which investigated the forest products situation reported in October that to maintain minimum supplies of pulp products direct action would be necessary to replenish the labour force in the forests and maintain it at the necessary level. Some measure of curtailment of paper consumption is also considered inevitable.

Towards the end of 1943, the Board was faced with new problems of materials coming or likely to come into partly surplus supply, and, in common with the other combined boards, the functions of the Board were also widened to include the responsibility for making allocations necessary to meet the raw material requirements of territories to be liberated from the enemy. There were no major developments during the year in the actual organization of the Board or its machinery. The final section of the report stresses the dependence of both the United States and the United Kingdom on raw materials from overseas, and the relatively ample endowment in raw materials on which they and the other allied industrial powers have been able to draw.

Post-War Plans for Science

A MEMORANDUM on "Post-war Plans for Science", issued by the Association of Scientific Workers, gives a précis of the statement "Scientific Research and the Universities", issued by the Parliamentary and Scientific Committee, and a more critical review of "A National Policy for Industry" issued by 120 industrialists and of the report "Industry and Research" issued by the Federation of British Industries Industrial Research Committee last autumn, all of which have been discussed in NATURE. Commenting on the proposals by the industrialists for the closer organization of industry, the memorandum urges that organization of the community would be necessary to ensure that the spirit of the proposals is given effect and that the compulsory powers are not abused. With regard to the recommendations of the Federation of British Industries, the memorandum directs attention to the absence of any practical suggestion whereby the consumers or the State could participate in the decision whether certain work should be undertaken because the consumer requires it, or that the Department of Scientific Research should be encouraged to spend more on nationally owned and controlled research institutes for various industries where the results would be published for the benefit of all. While the memorandum sounds a warning against sectional interests being allowed to stunt proposals good and proper in themselves, and calls for a wider vision of the national interest, its criticism is marred by the subjective approach. The prejudice against private industry with which the memorandum starts appears to have clouded judgment to the extent that the writer is more concerned to voice suspicions of any proposals from such a source than to submit them to objective and impartial analysis.

Mineral Resources of Tanganyika

THE Department of Lands and Mines (Geological Division), Tanganyika Territory, has issued an account of the mineral resources of the Territory prepared by Sir Edmund Teale and F. Oates (Bull. 16. Dar es Salaam, 1943. 15*s.*). This bulletin contains, in Part 1, an account of the relatively few mineral deposits that are, or have recently been, worked in Tanganyika. Part 2 includes a much longer list of economic minerals the occurrence of which has been recorded in the Territory, though in many cases in small quantities only. Notes on the manner in which these minerals occur are given, with the view of assisting would-be prospectors.

Further and more systematic exploration appears to be necessary before it can be said that the economic possibilities of these deposits can be properly assessed. Part 3 contains a summary of information regarding certain specially selected minerals, for consideration in reviewing the actual and potential mineral resources of Tanganyika, more particularly in regard to war-time requirements.

Staff Selection

A PAPER (*J. Inst. Elec. Eng.*, **91**, Pt. 1, No. 40; April 1944) by Messrs. R. C. Woods and A. S. MacDonald discusses staff selection by scientific methods, and makes reference to the designing of tests and to the means of proving their usefulness. The use of statistical methods is considered, a number of tests being described and samples given. The application of these principles to the staff selection problems in a light electrical engineering factory is described, the procedure for staffing a new department is detailed, and reference is made to the other classes of labour which are dealt with in the factory. A note on the selection of engineer apprentices is included. The last section of the paper deals with the technique of the interview. Finally, the authors mention the origin and growth of their work as indicative of its usefulness, and refer to co-operation between various departments in the factory which are concerned with personnel.

School Hygiene in Peru

ACCORDING to an annotation in the September issue of the *Boletín de la Oficina Sanitaria Panamericana*, school hygiene in Peru includes psychobiological investigation of childhood and adolescence, school health medical supervision and physical education. A special week is also set apart for an intensive programme in health education for the whole country. During the second half of 1941, 10,000 children between six and ten years were immunized against diphtheria. Medical examination of teachers before appointment has become the general practice. Sanatorium schools for tuberculous children, some of which are built in the higher altitudes with appropriate climatic conditions, have been established. Retarded children are being given attention and transferred to special schools.

Earthquakes Registered in Spain

DURING January 1944, twenty-nine earthquakes were registered by the seismographs at the Geophysical Observatory at Toledo. The greatest of these happened on January 16 and registered at Toledo at 00h. 02m. 41s., attaining a ground amplitude of 90μ at the Observatory. The earthquake was destructive in the province of San Juan in Argentina, South America. The nearest earthquake to Toledo during the month occurred on January 7, when eP_gz registered at 12h. 31m. 09s. from an estimated epicentral distance of 230 km.

Gas Industry in Great Britain

THE Minister of Fuel and Power has appointed the following committee of inquiry into the gas industry: Mr. Geoffrey Heyworth (*chairman*), Mr. Stuart Cooper, Sir Jonathan Davidson, Mr. Gavin Martin and Prof. D. M. Newitt. The secretary of the committee will be Mr. A. F. James, of the Ministry of Fuel and Power, to whom all communications should be addressed at the Gas and Electricity Division, Ministry of Fuel and Power, New Oxford House, Bloomsbury Way, W.C.1.

The terms of reference of the committee are: "To review the structure and organization of the gas industry, to advise what changes have now become necessary in order to develop and cheapen gas supplies to all types of consumers, and to make recommendations".

Announcements

FRANKLIN MEDALS for 1944 have been awarded to Dr. W. D. Coolidge, vice-president and director of research for the General Electric Company, for his development of the X-ray tube, and to Dr. P. Kapitza, director of the Institute for Physical Problems, Academy of Sciences of the U.S.S.R., for his work on extraordinarily high magnetic fields, and for designing an efficient liquid hydrogen machine.

DR. S. LIVINGSTON SMITH, superintendent of the Engineering Department at the National Physical Laboratory, Teddington, has been appointed director of research of the British Shipbuilding Research Association recently formed by the Shipbuilding Conference in close co-operation with the Department of Scientific and Industrial Research.

DR. A. J. V. UNDERWOOD has resigned from the position of joint honorary secretary of the Institution of Chemical Engineers which he has held for the last eight years.

DR. R. E. G. ARMATTOE, director of the Lomeshie Research Centre for Anthropology and Human Biology, and honorary physician in charge of Brooke Park (E.M.S.), Londonderry, has been elected a foreign member of the American Association of Physical Anthropologists.

DR. CHARLES OCKRENT, who has been working during the War in the Ministry of Supply and more recently has been acting in an advisory capacity in Scotland on the application of scientific control and instrumentation in industry, has been appointed to the scientific staff of the British Drug Houses, Ltd., as manager of production and development.

THE following appointments have been made in the Colonial Service: R. D. Linton, agricultural officer, Tanganyika, to be senior agricultural officer, Tanganyika; G. W. Nye, deputy director of agriculture, Uganda, to be director of agriculture, Nyasaland; A. S. Richardson, director of agriculture, Nyasaland, to be director of agriculture, Uganda; E. G. Staples, senior agricultural officer, Uganda, to be director of agriculture, British Honduras; A. S. Stenhouse, agricultural officer, Tanganyika, to be senior agricultural officer, Tanganyika; W. A. Burns, G. S. Cowin, M. A. Molloy and N. R. Reid, veterinary officers, Tanganyika, to be senior veterinary officers, Tanganyika.

WE have received from the Freshwater Biological Association a copy of Scientific Publication No. 8 which takes the form of "Keys to the British Species of Aquatic Megaloptera and Neuroptera", written by D. E. Kimmins of the British Museum (Natural History). It provides an admirable account of these insects accompanied by excellent original illustrations of their chief structural features. Its low price of 1*s*. 6*d*. should ensure it being in the hands not only of entomologists but also of all students of the freshwater fauna. It can be obtained from the Director, Freshwater Biological Association, Wray Castle, Ambleside, Westmorland.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Evolution of Modern Man (*Homo sapiens*)

THE discovery of a fossil human skull near Keilor, an outer suburb of Melbourne, is a matter of high importance to students of human evolution, who will certainly welcome Dr. Zeuner's[1] confirmation of the great antiquity attributed to it by Mr. D. J. Mahony, namely, that it represents a native Australian of the last (Riss – Würm) interglacial period. In seeking for the homeland of this ancient representative of *Homo sapiens*, neither Dr. Zeuner nor Dr. Wunderly, who was entrusted with the description of the skull, allude to the most probable source of the aboriginal population of Australia, namely, the early pleistocene races of Java, typified by *Pithecanthropus erectus*.

The first to suspect that the Australian aborigines were related to the ancient Javanese was Hermann Klaatsch, who visited Australia in 1904 to make a study of the aboriginal skull. In a report issued in 1908[2] this passage occurs: "My recent experiences show so many connections between Pithecanthropus and Australian and Tasmanian skulls that I am more inclined than before to accept a very close approximation of Pithecanthropus to the first tribe of human beings". The next link in the chain of evidence came in 1914 when the British Association visited Australia. The Talgai skull was then examined and accepted as probably of pleistocene age, an assumption now vindicated by the discovery of the Keilor specimen, for the Talgai, to my eye, is the more primitive of the two. Then, in 1920, Eugène Dubois published an account of two ancient skulls from Wadjak, in Java; he regarded them (I think rightly) as Proto-Australian in type. Even so late as 1931, I was still in doubt as to the ancestral position of Pithecanthropus[3]. Then, with the discovery of later fossil types in Java by Dr. Oppenoorth in 1932, and the subsequent additions made to the Pithecanthropoid family by Dr. G. von Koenigswald, it seemed to me the chain of evidence that links the Australian aborigine of to-day with Pithecanthropus of the early pleistocene was complete, and I said so in 1936[4]. In a great monograph which has just appeared[5], Dr. Weidenreich has reached independently the same conclusion as to the origin of one type of modern man—the aboriginal type of Australia.

Dr. Weidenreich and I are also in agreement in tracing the Bushman of South Africa from the primitive fossil type found in Northern Rhodesia—*Homo rhodesiensis*; we are also both convinced that Sinanthropus lies on or near the line which gave rise to races of the Mongolian type. Here, then, are three of the present-day types of man traced to separate pleistocene origins. Most of us who, a decade ago, were making a special study of the fossil remains of man believed that we should find, some day, the remains of a type which would serve as an ancestor for all living races, and that we should find this ancestral type spreading abroad in the world, exterminating the other early pleistocene types; all the evidence has gone against this supposition. The only man, so far as I know, who guessed that living human races had, in a physical sense, approached nearer to each other as time went on was the Swiss anthropologist, Karl Vogt[6]. Darwin considered Vogt's suggestion, but rejected it as improbable[7]. Yet it is known that convergence of a very similar nature took place in the evolution of horses.

I have mentioned that as regards the origin of modern races of mankind, Dr. Weidenreich and I have reached a large measure of agreement, all save in the case of that most ancient of Englishmen, Piltdown man (Eoanthropus). Dr. Weidenreich is of the belief that all surviving races of mankind have passed through a "Neanderthaloid" stage in their evolution, a stage which was apparently omitted in the case of Piltdown man. He is therefore removed by Dr. Weidenreich from the list of authentic fossil men, his skull being assigned to a modern type of man, while his lower jaw is given to a fossil anthropoid akin to the orang. Virchow solved the mixed simian characters of Pithecanthropus in a similar way, assigning the skull to an ape and the femur to a man. In England we find it hard to believe that there lived in the Weald of Sussex, in earliest pleistocene times, a modern type of man and a rather human-like ape, and that by some strange chance the bones of these two became mingled in the Piltdown gravel bed. Not only was the Piltdown race alive in England when the rest of Europe seems to have been occupied by human stock of the Neanderthal breed, but also this ancient race appears to have come down to mid-pleistocene times; at least it is on such a supposition we can best explain the characters of the Swanscombe and London fossil skulls.

Another problem bearing on the evolution of modern races has again cropped up in connexion with the discovery of the Keilor fossil skull. This skull exhibits a mixture of Tasmanian and Australian features. Dr. Wunderly explains the mixture by regarding Keilor man as a hybrid—the result of a union between Tasmanian and Australian races. We do not know of the existence of these two races until long after the Keilor period; if we believe in evolution, then our attitude to Keilor man should be to regard him as a representative of the ancestral stock from which both Tasmanian and Australian races have emerged. The same problem arises in connexion with the Skhūl people of Mount Carmel. They possess both Neanderthal and 'modern' (Cro-magnon) features. Dr. McCown and I explained the mixture by regarding the Skhūl people as transitional between the older Neanderthal type and the recent or modern type[8]. Those who maintain that the Skhūl people are the mixed progeny of Neander – Modern parents must first convince us that the modern type of man was in existence before the Riss – Würm interglacial period.

ARTHUR KEITH.

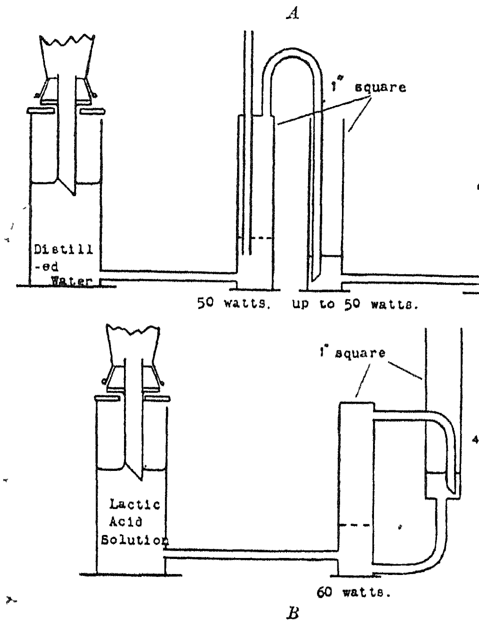
Downe, Kent.
May 22.

[1] NATURE, **153**, 622 (1944).
[2] Reports from the Path. Lab., Lunacy Dept., N.S.W., **1**, 163 (1908).
[3] "New Discoveries Relating to the Antiquity of Man", 28, 312.
[4] NATURE, **138**, 194 (1936).
[5] "The Skull of *Sinanthropus pekinensis*; a Comparative Study on a Primitive Hominid Skull", *Palæontologica Sinica*, No. 127 (Dec. 1943).
[6] Vogt, Karl, "Lectures on Man", 468 (1864).
[7] "Descent of Man", Chap. 7, Pt. 1, 274.
[8] McCown and Keith, "The Stone-Age of Mount Carmel", **2** (Oxford, 1939).

Vaporization of Lactic Acid as an Aerial Bactericide

In an earlier communication[1], an account was given of the bactericidal action of lactic acid vapour. Further work has shown that the methods of vaporization used until that time were inefficient, and that effective bactericidal action is obtained when the concentration of acid vapour in the air is 3·5 mgm./cu. metre.

Lactic acid cannot be boiled at ordinary pressures without decomposition. Dropping the acid or its aqueous solution on to a hot plate also leads to considerable loss of acid. Dispersal as a fine spray is satisfactory from the point of view of avoiding loss or decomposition of acid; but for continuous operation needs cumbersome and expensive apparatus. Lactic acid is, however, readily volatile in superheated steam, and two forms of apparatus for effecting this have been devised and are shown in the accompanying diagram. With appropriate modifications they are, of course, also suitable for the vaporization of other bactericidal substances volatile in steam.



In type A, water is fed from a constant-head feed system into a closed electrically heated boiler. The steam from this boiler is then allowed to bubble through the lactic acid in an electrically heated pot into which the lactic acid is fed from another constant-head feed system. The rate of evolution of lactic acid vapour depends on (*a*) the rate of steam flow, to which it is directly proportional, (*b*) the temperature of the pot, which is maintained at any desired point between 120° and 180° C. by adjusting the heat supply.

In type B an aqueous solution of lactic acid is fed into a closed electrically heated boiler from a single constant-head feed system. The water is largely boiled off and the concentrated lactic acid passes into an electrically heated pot. The steam from the first boiler is allowed to blow off through the lactic acid in this pot. The wattages of the two heaters are adjusted to maintain the second pot between 120° and 180° C. For given wattages the temperature of the second pot and the output of vaporized lactic acid are controlled by the concentration of the initial lactic acid solution, which may be varied from zero up to 20 per cent lactic acid by weight. For smooth working the boiler must have adequate thermal capacity; a mass of 250 gm. of brass is usually sufficient, but twice this is preferable.

Both types, as illustrated, have a maximum output of about 12 gm. of lactic acid vaporized per hour, and have been constructed mainly from brass, with all joints brazed. Corrosion of the metal and formation of non-volatile polymers appear to be negligible under working conditions; but it is probably desirable to flush out the system occasionally. Distilled water must, of course, always be used to avoid furring up the boiler.

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Role of Manganese in the Biological Synthesis of Ascorbic Acid

I HAVE adduced evidence[1] that manganese has a specific role in the synthesis of ascorbic acid by plants and animals. Until now the evidence of the synthesis of ascorbic acid in presence of manganese has been chemical; that is, by titration with the indophenol reagent. Evidence that the indophenol-reducing substance synthesized is identical with vitamin C has now been obtained.

Phaseolus radiatus seeds were germinated in distilled water and in separate and mixed dilute solutions of sodium chloride, magnesium sulphate and manganous chloride. The grains germinated in solutions containing manganese, within certain minimal concentration, alone showed a largely increased synthesis of ascorbic acid; the other salts had no effect upon the synthesis of ascorbic acid. Young growing guinea pigs were divided into three groups and kept on a scorbutic diet of oatmeal, 63; bran, 10; casein, 20; linseed oil, 2; codliver oil, 2; sodium chloride, 1; calcium phosphate, 2. One group was supplemented daily with 0·5 mgm. of synthetic ascorbic acid. The second group was supplemented with a given amount of *Phaseolus radiatus* germinated in distilled water for one day and calculated to contain 0·5 mgm. of total (reduced and dehydro-) ascorbic acid. The third group was similarly supplemented with a given (smaller) weight of *Phaseolus radiatus* germinated in 0·002 per cent manganese solution for one day and containing 0·5 mgm. of total ascorbic acid. The experiment lasted three weeks.

The results are given in the accompanying table. The two groups supplemented with germinated *Phaseolus radiatus* showed exact parallelism in their growth-rate, and closely agreed with the growth-rate of the group supplemented with synthetic ascorbic acid. This establishes the identity of the increased indophenol-reducing substance synthesized by *Phaseolus radiatus* when germinated in 0·002 per cent manganese solution with vitamin C.

In another set of experiments guinea pigs (120–150 gm. in weight) kept on the above scorbutic diet were divided into two groups. One group was

Substance fed	Ascorbic acid content (av. of 3 weeks) (mgm./gm original seeds)	Ascorbic acid fed (mgm.)	No. of pigs	Av. initial wt. (gm.)	Av. wt after 3 weeks (gm.)	Av. increase in wt. after 3 weeks (gm.)
Synthetic ascorbic acid	—	0·5	6	115	181	66
Phaseolus radiatus germinated in distilled water	0 80	0 5	6	116	176	60
Phaseolus radiatus germinated in 0 002% Mn	1 03	0·5	6	106	165 5	59·5

given intraperitoneal injections of 25 mgm. glucose dissolved in ½ ml. of distilled water. The second group similarly received 25 mgm. glucose dissolved in ½ ml. of 0·04 per cent manganese solution. The injections were given daily for 14 days and then the animals were killed, cross-sections of the root of lower incisors taken, the histological structure studied and the degree of protection against scurvy judged according to the Key and Elphick[2] scale. The number of animals employed in each group was five.

The animals in the group injected with glucose alone had a degree of protection of 0, showing that no synthesis of ascorbic acid had taken place in these animals. The animals in the group injected with glucose in manganese solution had, on the other hand, an average degree of protection of about 3. Some animals had complete protection (degree 4) against scurvy (see photograph). This proves that the animals injected with glucose in manganese solution had synthesized ascorbic acid, thus affording themselves partial or complete protection.

The experiments recorded above support my hypothesis that manganese is indispensable for the synthesis of ascorbic acid by animals and plants, and that the non-synthesis of the vitamin in primates and the guinea pig is due to an insufficiency of the metal at the seat (jejunum) of ascorbic acid synthesis. Further investigations are in progress.

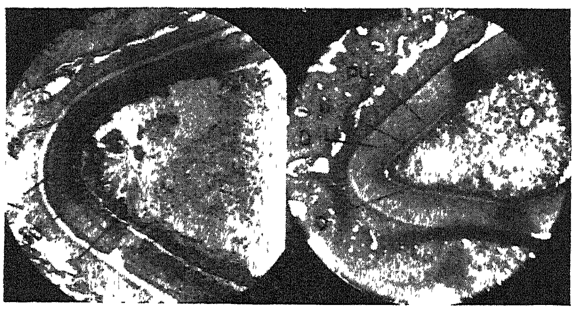

Fig. 1. Fig. 2.

Fig. 1. SECTION OF ROOT OF LOWER INCISOR OF GUINEA PIG INJECTED WITH GLUCOSE ONLY.
Degree of protection, 0. Narrow dentine; wide calcified predentine; wide inner dentine; odontoblasts disorganized and migrating into pulp which is also disorganized.

Fig. 2. SECTION OF ROOT OF LOWER INCISOR OF GUINEA PIG INJECTED WITH GLUCOSE IN MANGANESE SOLUTION.
Degree of protection, 4. Wide dentine; narrow uncalcified predentine; inner dentine absent; odontoblasts long and parallel; pulp normal.

D, dentine; *p*, predentine; *I.D.*, inner dentine; *O*, odontoblasts; *pu*, pulp.

I wish to record my grateful acknowledgment to the governing body of the Indian Research Fund Association for placing funds for this investigation at my disposal.

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Dried Potato Products and Nutritional Encephalomalacia in Chicks

THE feeding value of dried potato products has been investigated at the Agricultural Research Institute of Northern Ireland, chiefly from the point of view of their value as substitutes for maize meal and other cereal products in rations for pigs and poultry. Excellent results have been secured with fattening pigs[1,2], in agreement with Woodman's results[3]. Preliminary experience suggests that such products are satisfactory substitutes for maize meal in the rations of laying pullets kept on good grass runs[1].

We have also attempted to replace the maize meal in a practical chick ration by dried potato meal manufactured by drying potato slices in direct contact with flue gases. The control ration consisted of maize meal 51·5 per cent, wheat-feed 20 per cent, fish meal 10 per cent, earthnut cake meal 5 per cent, dried liver meal 5 per cent, cod-liver oil ('controlled mixture') 2 per cent, mineral mixture 1·5 per cent. This ration was based on a successful ration used in assessing the value of dried liver meal produced in Northern Ireland as a riboflavin-rich protein supplement[1].

Replacement of the maize meal of this control ration by the dried potato meal led to serious symptoms of nutritional deficiency and mortality from about the middle of the second week onward. Deficiencies of vitamins A and D were ruled out by the inclusion of adequate cod-liver oil in the rations, the absence of symptoms of rickets and the presence of considerable reserves of vitamin A in the livers *post mortem*; the dried liver meal was known to supply adequate riboflavin[4]; the condition did not respond to dried yeast or to massive doses of thiamin hydrochloride or pyridoxin; and calculation seemed to exonerate pantothenic acid deficiency, especially in view of the absence of dermatitis.

Afterwards, Dr. Blakemore, of the Institute of Animal Pathology, Cambridge, directed our attention to Asplin's work[5] on an outbreak of nutritional encephalomalacia in Great Britain. Asplin's clinical description applies in detail to the clinical picture observed by us, except that we have also noted well-marked intermittent tremors, as though the heat-regulatory system was impaired. Such tremors, however, are included among the symptoms of 'crazy chick disease' (nutritional encephalomalacia) by Titus[6].

We have now repeated these experiments with rations essentially similar to that described above and have confirmed the diagnosis of nutritional encephalomalacia from the occurrence of the characteristic massive œdema of the cerebellum and pinpoint hæmorrhages of its surface in affected chicks;

Prof. J. H. Biggart has very kindly further confirmed the nature of the brain lesions by sectioning.

While our work on this subject is not yet completed, we think it advisable to direct attention to these observations in view of their possible practical significance. It is possible under war-time conditions that potatoes and dried potato products may frequently be regarded as cereal substitutes in chick-rearing rations, which are also likely to contain cod-liver oil. Incorporation of cod-liver oil with cereal products is well known to lead to oxidative destruction of vitamins E, and where the proportion of cereal is low or stale meals are used, nutritional encephalomalacia may be encountered. It is clear that, under war-time conditions, obscure types of leg-weakness other than rickets or curled-toe paralysis (riboflavin deficiency) may be due to nutritional encephalomalacia and should be checked by macroscopic and, where possible, microscopic examination of the cerebellum.

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p-Cresol and Œstrone in Urine

THE presence of *p*-cresol in human urine, as well as in the urine of horses, cows and other animals, has been known for a long time. It occurs mainly as a salt of *p*-tolylsulphuric acid. According to Siegfried and Zimmermann[1], the average concentration of *p*-cresol in normal human urine is of the order of 18 mgm. per litre, and in a man with an adrenal tumour a value of 25 mgm. per litre has been reported[2]. In the urine of pregnant mares, Marshall has found that the concentration is 60 mgm. per litre[3].

It is significant that these increases in *p*-cresol are accompanied by corresponding increases in the concentrations of œstrogenic hormones, mainly œstrone, present in the urine, which have been reported as 0·016 mgm., 0·3 mgm. and 10 mgm. per litre respectively in the three cases. The urine of stallions provides an even richer source of œstrone, the concentration reported being of the order of 17 mgm. per litre[4]. We have confirmed this figure for total œstrogen, and in addition have found that the concentration of *p*-cresol in this instance reaches the remarkably high value of 550 mgm. per litre. Approximately 25 gm. of *p*-cresol (benzoate, m.p. 72°; aryloxyacetic acid derivative, m.p. 134°) were isolated from the strong phenolic fraction from 10 gallons of the mixed acid-hydrolysed urine from two stallions. It is also known that the œstrone content of human urine increases progressively during pregnancy, and Falsia[5] has reported that there is a corresponding increase in the *p*-cresol content.

The origin of the phenol and cresols in urine is usually attributed to tyrosine, and in support of this view it has been claimed that the concentration of phenols in urine increases with an increase in protein intake. On the other hand, Fricke[6] has pointed out that the phenolic constituents of urine are most abundant in Herbivora, and has claimed that the quantity in human urine is increased on a vegetable diet. These considerations seem to indicate that tyrosine and intestinal putrefaction may not be the sole source of phenols in urine, and the above correlation between the elimination of œstrone and *p*-cresol suggests the possibility that not only the former but also the latter may be derived from the male hormone or some related steroid. On this basis the *p*-cresol could arise from ring *A* of the steroid molecule, in which the hydroxyl and methyl group are correctly placed. This possible connexion between the natural sex hormone and simple phenols, coupled with the known œstrogenic activity of many phenolic compounds of comparatively simple structure, recalls the suggestion, originally due to Dodds[7], that the true œstrogenic agents may be relatively simple compounds resulting from the breakdown of the cyclopentanopolyhydrophenanthrene system.

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A Search for Endemic Areas of Trichinosis in Great Britain

ALTHOUGH the life-history of *Trichinella spiralis* has been known for nearly a century, we are still very ignorant of the epidemiology of trichinosis in man—a gap in our knowledge which remained unsuspected until Hall[1] discovered the frequent occurrence of sub-clinical human infestation in the United States. A repetition of Hall's work more recently carried out in Great Britain by Van Someren[2] and later by Miss M. Young[3] has revealed that a similarly high incidence of infection is to be found here. Interest in the epidemiology of the infection in Great Britain has been still further stimulated by the outbreaks of clinical trichinosis which occurred during the winter of 1940–41 at Wolverhampton, Penrith and Harpenden[4,5] accentuating the urgency for the discovery of the origin of infection.

In the past, it has been generally supposed that outbreaks of trichinosis in Great Britain are traceable to the importation of infected pork, which occasionally finds its way through the meat inspection; but this now appears to be an inadequate explanation, and it seems more than likely that reservoirs of infection exist among animals in our own country.

Although Leiper[6] was able to demonstrate infection in rats at centres where trichinosis had been diagnosed in man, the general incidence of rat infection throughout Great Britain appears to be very low. The attempted detection of hitherto unrecognized endemic areas through the examination of rat carcases appeared therefore to be an unpromising line of research, and it was thought that the examination of the carcases of rat-eating animals might be more likely to produce a result, as their skeletal muscles would present evidence of trichinosed flesh having been eaten at any time during their whole lives. Some 636 stoats, 78 weasels and 2 polecats were secured for this purpose, through the medium of the pest officers in various counties, and were subjected to a thorough examination. In this process

portions of the masseter muscles, intercostal muscles, tongue, muscles of the hind leg and the whole of the diaphragm were examined as crush preparations under the microscope. The rest of the muscle was then cut off the bones and subjected to peptic digestion and afterwards examined, but the whole laborious and malodorous process was carried out without revealing the presence of a single larva of *Trichinella spiralis*.

The carcases received for examination came from the following counties: Northumberland 11, Cumberland 74, Westmorland 39, Lancashire 148, Yorkshire 42, Cheshire 6, Lincoln 106, Flint 2, Nottingham 21, Leicester 1, Shropshire 4, Warwick 1, Worcester 15, Rutland 1, Northampton 3, Huntingdon 4, Cambridge 3, Norfolk 29, Suffolk 8, Oxford 8, Hereford 2, Gloucester 26, Berkshire 2, Buckingham 15, Bedford 1, Hertfordshire 2, Surrey 1, Hampshire 17, Wiltshire 5, Dorset 12, Somerset 1, Devon 2, Isle of Wight 2, Caernarvon 52, Montgomery 3, Radnor 3, Pembroke 1, Glamorgan 2 and Carmarthen 5. (The uneven distribution of the animals does not in any way reflect their distribution throughout the country as a whole, but only the facilities at the disposal of the various pest officers.)

Experimental feeding of trichinosed flesh to ferrets, which animals are believed to be domesticated polecats, showed that infection very readily occurred. The mink is also known to be very susceptible, and there is every reason for believing that were trichinosis at all prevalent among the rats in any district from which wild mustelids were examined, the larval parasites would have been found. It is unfortunate that we were unable to secure stoats or weasels from any of the regions in which trichinosis had recently appeared in man; but even in the absence of this positive control to the observations, it is considered that the negative findings in 716 small Carnivora from so many widely distributed parts is a useful indication of the sparse distribution of *Trichinella spiralis* throughout England, and suggests that reservoirs of infection are confined to a few relatively small areas.

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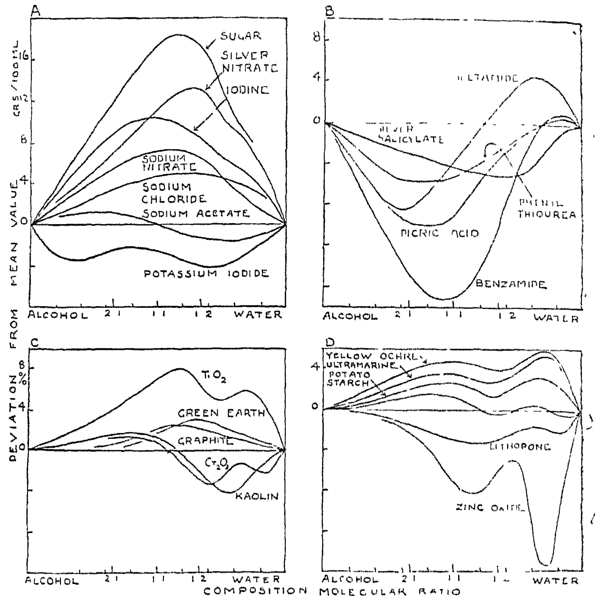
Flocculation in Solutions and Suspensions

FLOCCULATION in suspensions of finely divided solids in liquids can be readily demonstrated either by microscopic examination or by experimental methods; flocculation is mainly the cause of anomalous viscosity behaviour and thixotropy.

Solute particles, whether of sodium chloride, mercuric bromide, soaps or shellac, appear also to be aggregated in some circumstances, and this is demonstrated by comparing the properties of the solutions with those of the suspensions, especially in mixed liquids. The degree of flocculation of a suspension can be gauged by the ultimate sediment volume and rate of sedimentation, flocculation being associated with a large sediment volume and a relatively high rate of sedimentation. In the accompanying graphs



RELATION BETWEEN DEVIATIONS FROM MEAN SOLUBILITY AND SEDIMENT VOLUME (ORDINATES) AND MOLECULAR COMPOSITION (ABSCISSÆ) FOR SOLUTIONS AND SUSPENSIONS IN ALCOHOL - WATER MIXTURES.

are compared, for solutions and suspensions in ethyl alcohol – water mixtures, the deviation below the mean solubility value of several crystalloids and the deviation above the mean value of sediment volumes of several finely divided pigments. The shapes of the curves are similar, there being a maximum deviation in the neighbourhood of the composition two molecules water, one molecule alcohol.

The specific viscosity of salt solutions, colloidal solutions and suspensions alike varies with the viscosity of the liquid medium, being lower in liquids of low viscosity than in viscous media[1]. The specific viscosity of solutions of mercuric salts, aluminium chloride, sodium chloride, etc., and of suspensions of zinc oxide, titanium oxide, etc., in alcohol increases with addition of water following the increased viscosity of the medium.

The explanation of this behaviour that the higher specific viscosities are due to the longer times of orientation of asymmetric particles in the more viscous liquids can be amplified by assuming the presence of flocks which tend to orientate and break up in the stream of flow. Flocculation, akin to the sol $\rightleftharpoons$ gel transition, is a kinetic process, the solvated particles on collision tending to aggregate momentarily at least. In liquids of higher viscosity the particles moving more slowly and with a kinetic energy less in proportion to the increase in viscosity are less likely to disengage themselves from the cohesive force after collision.

With colloidal solutions of cellulose derivatives, proteins, resins and other large-molecule substances in mixed liquids, it is usually found that above a certain concentration the optimum solvent mixture yields solutions of minimum viscosity, and Palit[2] has shown that these are affected less by temperature than those in other mixtures. With the optimum solvent mixture there is a nearest approach to a solution of single molecules, which is less affected by temperature than mixtures containing higher proportions of flocculated particles. Palit, from his work on shellac, has expressed the view that the explana-

tion of the viscosity behaviour in mixed liquids has its roots in the gelation (flocculation) capacity of the system, and such solutions above the minimum gelation concentration may be regarded in a limited sense as incipient gels. In other words, in solutions of some concentration and in the poorer solvents, such as, for example, in the mixture two molecules water one molecule alcohol, the solute molecules are to a greater or less extent in an aggregated state.

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Singlet Terms in the Spectrum of Molecular Nitrogen

IN recent papers communicated at about the same date, one of us[1] has reported a number of singlet band systems in the absorption spectrum of nitrogen in the extreme ultra-violet, while the other[2] has given details of several singlet systems obtained in emission in the near ultra-violet. These two sets of systems do not have any electronic levels in common as they are of different symmetry, but unfortunately the same letters have been used by both of us in designating some of the electronic states.

To avoid confusion, we suggest that primes be affixed for the upper states p, q, r, s and t of the new emission systems, while the lower level of the Fifth Positive (van der Ziel) system and of Kaplan's systems be designated a' instead of v. (a' and a would then occupy a position roughly analogous to that of b' and b.) We shall also refer to state o' as o (without prime), as it is now[1] scarcely necessary to emphasize its distinction from an earlier, but discarded, o grouping.

The known singlet states of molecular nitrogen are listed here using the revised notation. For convenience we include an abbreviated table of the most important constants, in which some of the values have been slightly 'rounded'. The vibrational constants of the normal state, and ν_0 for $a^1\Pi$ and $b'^1\Sigma$ are from Birge and Hopfield[3]. The value for B_0 of $X^1\Sigma$ has been discussed previously (ref. 1, footnote 37). Levels g, f and h, which may not all be separate states[1], have been extrapolated from measurements by Watson and Koontz[4]. The constants for b' are from Tschulanowsky[5]; for other states designated by primes and for a, w, x and y, they are derived from a study of emission systems in the near ultra-violet[2]. Absorption systems in the far ultra-violet provide slightly less accurate data for the remaining states[1]. Values of B and ω enclosed in parentheses correspond to the stronger absorption bands of a v'-progression for which the (0, 0) band was probably not observed; they are presumed to be associated with levels for which $r'_{\min.} \sim r_0''$. In these cases, estimated potential minima ($\sim \nu_e$) are given[1].

The apparent absence of absorption to levels x and y makes it likely that these states are of g symmetry. State a' would then be of type $^1\Sigma_u^-$, and would probably correspond to one of this character predicted on theoretical grounds, namely, by addition of a $\sigma_g 2p$ (that is, anti-bonding $v\pi$) electron to the low-lying $^2\Pi_u$ state[6] of N_2+. Level a' would then be metastable, irrespective of whether it lies above or below $a^1\Pi_u$, and may thus be of importance in the formation of active nitrogen.

State		ν_0 ($\sim\nu_e$)	B_0 (B_v)	$\omega_{1/2}$(ω_v)
v	$?_u$	(119,000) ?	($\lesssim$1·9)	(925)
u	$^1\Sigma_u^+$	(116,000)	(1·07)	(530)
t	$?_u$	(115,000) ?	(1·04)	(460)
s	$?_u$	(113,000) ?	(1·06)	(500)
t'	$^1\Sigma_g^-$	112,774	1·63	
h	$?_u$	112,770	$\lesssim$1·9	
s'	$^1\Sigma_g^-$	110,662	1·58$_5$	
f	$?_u$	110,190 E	$\lesssim$1·9	
g	$?_u$	108,950 E	<1·99	
o	$?_u$	107,655 H*	$\lesssim$1·8	1918
r	$^1\Sigma_u^+$	(107,000)	(1·06)	(630)
y	$^1\Pi_g$ (or $^1\Pi_u$)	a'+ 46,420	1·80	1705 ?
r'	$^1\Sigma_g^-$	106,373	1·67	
x	$^1\Sigma_g^-$ (or $^1\Sigma_u^+$)	a' + 45,463	1·73$_5$	1869
q'	$^1\Pi_g$	05,351	1·36$_5$	
q	$^1\Pi_u$	(105,000)	(1·09)	(670)
p'	$^1\Sigma_g$	104,328	1·93	
c	$^1\Pi_u$	104,316 H	1·92	2180
p	$^1\Pi_u$	(104,000)	(1·21)	(730)
b'	$^{1-+}$	103,678 E	1·144	741·3
m	$^1\Sigma_u^+$ (or $^1\Pi_u$)	(103,000)	(1·35)	(760)
b	$^1\Pi_u$	101,454 H	1·41	698
w	$?_g$ (or $?_u$)	a' + 40,914	>1·47	1711 ?
j	$^1\Sigma_u^+$	(99,000) ?	(1·45)	
i	$?_u$	(97,000) ?	($\sim$1·5) ?	(670)
a	$^1\Pi_u$	68,956	1·61	1666·7
a'	$^1\Sigma_u^-$ (or $^1\Sigma_g^+$)	$\sim$ 60,000	1·47	1504
X	$^1\Sigma_g^+$	0	1·99$_5$	2330·7

H, observed head of (0,0) band. E, extrapolated head of (0,0) band.

* or ν_0 = 105,693, $\omega_{1/2}$ = 1962.

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The Black Redstart

IN his interesting article on the black redstart in NATURE of May 27, Mr. Fitter says that it "was not known to breed anywhere in the British Isles before 1923". It is well over forty years ago that I watched a pair of these birds throughout their nesting activities at Bush Hill Park, near Enfield in Middlesex. I regret that in the end I took the clutch of four eggs. These eggs were sold at Stevens' auction on July 16, 1918 (Sale No. 12,981, Lot 53) on my leaving England and after this interval I can give no more precise data.

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RADIOCHEMISTRY OF AQUEOUS SOLUTIONS

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IN a recent review of radiochemical reactions, that is, reactions induced by α-particles and particularly by X-rays, Allsopp[1] affirms the conclusion that in gaseous systems there is a great similarity between radiochemical and ordinary photochemical processes, and that their mechanisms are essentially the same. In solutions, however, where radiochemical reactions are of far greater biological importance, the situation is still rather obscure and is dominated by the very indefinite 'activated solvent' hypothesis. In view of the more recent work of Dale[2] on the effect of X-rays on enzymes and biologically active substances in solution, the subject has become of renewed interest.

An attempt is made here to show that the abovementioned parallelism can be extended to solutions, and furthermore that all the known facts on the radiochemistry of aqueous solutions can be interpreted on the basis of known photochemical or chemical reactions in solutions.

It is clear from the outset that the same general principles must apply to solutions as to gases, and consequently the same conclusions are reached: namely, that dissociation processes (in general preceded by excitation) are the direct and chemically most important result of the irradiation[3]. The only important difference lies in the fact that in solutions the active radiation is to a very large extent absorbed by the solvent.

Let us first examine briefly the radiochemical changes produced in water, for which the 'activated solvent' hypothesis was first developed by Risse[4] and later adopted by Fricke[5].

Water is composed of hydrogen ions and hydroxyl ions and does not absorb in the quartz ultra-violet region of the spectrum. The strong absorption in the region between 1800 and 2000 A. is due to the OH^- ions[6]. It is well known from the photochemistry of ions in solutions[7,15] that the photochemical primary processes consist in the detachment of an electron and its subsequent transfer from the ion to one of the neighbouring molecules or ions (electron affinity spectrum). In the absorption of radiation by the OH^- ion it loses its electron, which will be transferred to a neighbouring H^+ ion, so that the radiochemical primary process for pure water is represented by:

$$(HO)^-H^+ + \text{radiation} \rightarrow HO + H \quad . \; . \; . \quad (1)$$

or similarly:

$$(HO)^- H_2O + \text{radiation} \rightarrow HO + H + OH^- \quad . \; . \; . \quad (1a)$$

Although there is this primary splitting into hydrogen atoms and hydroxyl radicals, in general, no appreciable decomposition of the water will be observed. The reason is that the radiochemical primary process (reaction 1) is always followed by the recombination of the decomposition products according to*:

$$H + OH = H_2O \quad . \; . \; . \; . \; . \quad (2)$$

thus restoring the initial state.

* For well-known reasons this and all the following bimolecular association reactions require the presence of a third collision partner. However, this fact is of no particular importance for the present discussion.

Recombination processes of this type are specially favoured in solutions because the dissociation products primarily formed are held together by the surrounding solvent molecules[8]. Actual decomposition of pure water can only occur in so far as the subsequent reactions, namely:

$$\text{(Hydrogen formation)} \quad 2H = H_2 \quad . \; . \; . \; . \quad (3)$$

and

$$\text{(Oxygen formation)} \quad 2OH = H_2O + O \quad . \quad (4)$$
$$2O = O_2$$

can compete with the reverse reaction (2).

It is conceivable that a very small decomposition of pure water into hydrogen and oxygen molecules can occur under certain conditions; for example, if the hydrogen and hydroxyl fragments are formed with a very high kinetic energy and thus quickly removed from each other's sphere of action.

However, the situation is radically changed if there are present in the water substances which can interact chemically with the hydrogen atoms and hydroxyl radical primarily formed.

Both the hydrogen atoms, as free atoms, and the hydroxyl free radical are extremely reactive. The hydroxyl radical is a strong oxidizing agent which by accepting an electron is transformed into the OH^- ion, whereas the hydrogen atoms are powerful reducing agents. There are, therefore, scarcely any substances which, if dissolved in the water, will not be attacked by these powerful reagents and will thus act as acceptors towards one or the other of the radicals formed by the irradiation. The 'acceptor action' of different solutes is now a chemical matter and it will be discussed in the following for a few cases which have been investigated experimentally.

Molecular oxygen.

$$\text{Acceptor action:} \quad H + O_2 = HO_2 \quad . \; . \; . \; . \quad (5)$$

followed by

$$\text{hydrogen peroxide formation} \quad 2HO_2 = H_2O_2 + O_2 \quad . \; . \quad (6)$$

Reactions (1) and (2) account for the fact that water is not decomposed by X-rays in the absence of dissolved oxygen. While in the presence of the latter, one gets hydrogen peroxide simply because the hydrogen atoms are removed from the solution by reacting with oxygen molecules according to the well-known reaction (5)[9], which eventually leads to the formation of hydrogen peroxide, reaction (6). The remaining hydroxyl radicals from reaction (1) will then give molecular oxygen (reaction 4), which also enters into the process.

Hydrogen peroxide. Hydrogen peroxide—either formed from molecular oxygen, or starting with a solution of hydrogen peroxide in water—is not stable under these conditions because it can itself act as an acceptor for hydrogen atoms and hydroxyl radicals, as is well known from the thermal (catalytic) and photochemical decomposition of hydrogen peroxide[10]. These reactions are:

$$H_2O_2 + H = H_2O + OH \quad . \; . \; . \; . \; . \; . \quad (7)$$
$$H_2O_2 + OH = HO_2 + H_2O \quad . \; . \; . \; . \; . \; . \quad (8)$$
$$H_2O_2 + O_2^- = O_2 + OH + OH^- \quad . \; . \; . \quad (9)$$

where reactions (8) and (9) represent the well-known chain reactions[10]. It is clear that the interplay of the radicals H, OH, HO_2 (reactions 7, 8 and 9) will eventually lead to a stationary (maximum) concentration of hydrogen peroxide in the solution. This maximum concentration, because of reaction (9)—where the anion O_2^- of HO_2 enters—

will depend on the pH, alkaline pH favouring a lower stationary H_2O_2 concentration[11].

Iodine or bromine ions[12].

Acceptor action : $I^- + OH = I + OH^-$ (10)

Reaction (10), by eliminating the hydroxyl radicals, frees the hydrogen atoms, which will give molecular hydrogen. The iodine (or bromine) atoms combine to give molecular iodine (or bromine)

according to : $2I = I_2$ . . . . . . (11)

Reaction products : hydrogen, iodine (or bromine).

At alkaline pH, molecular bromine and iodine are to some extent converted into their oxy-acids. These oxy-acids are oxidizing agents and will act as acceptors towards the hydrogen atoms. In this way the hydroxyl radicals will become free and this will result in the formation of molecular oxygen according to reactions (4).

Ferrous salts[13].

Acceptor action : $Fe^{2+} + OH = Fe^{3+} + OH^-$ . . (12)

Reaction (12) frees the hydrogen atoms formed in the radiochemical primary process, which will then give molecular hydrogen (reaction 3). Reaction products : ferric salt, hydrogen.

Ceric salts[14].

Acceptor action : $Ce^{4+} + H = Ce^{3+} + H^+$ (13)

This frees the hydroxyl radicals, which will give rise to the formation of molecular oxygen (reactions 4).

Reaction products : cerous salt, oxygen.

It is clear that this can be extended also to any other substance. In general, if the solute has oxidizing qualities (for example, potassium permanganate, etc.), it will react with the hydrogen atoms and leave the hydroxyl radicals to form molecular oxygen[12,14]; on the other hand, if the solute has reducing properties, it will be oxidized by the hydroxyl, and the hydrogen atoms will give molecular hydrogen.

In the case of more complex organic molecules (for example, tyrosin enzymes, proteins) there will always be a reaction of the solute with the hydroxyl radicals (possibly also with hydrogen atoms) which will lead to its decomposition and deactivation. If no hydrogen or oxygen gas is evolved, one has to assume that both the radicals primarily formed have reacted with the solute.

Some quantitative relationships can be derived from the mechanism proposed above. In the simplest case, the radiochemical primary process (reaction 1) is followed by either recombination (reaction 2), or by an acceptor reaction of the general type :

$$S + OH \xrightarrow{k_S} \text{reaction products} \quad . \ . \ . \ . \quad (14)$$

where S represents a general solute acceptor molecule or ion. The rate of disappearance of the solute for the stationary state $\left(\frac{d\,[OH]}{dt} = 0\right)$ is then given by the equation :

$$-\frac{d(S)}{dt} = \frac{\varkappa\, k_S\, R_{abs.}\,[S]}{k_2\,[H] + k_S[S]}, \quad . \ . \ . \ . \ . \ . \quad (15)$$

where k_2 and k_S are the rate constants of reactions (2) and (14), and $R_{abs.}$ denotes the total radiation absorbed per unit of time ($\varkappa$ proportionality factor ; brackets represent, as usual, concentrations in gm. mols per litre).

If $k_2[H] < k_S\,[S]$, ... (16)

that is, if the reaction with the substrate is rapid compared with the reverse process (2), this simplifies to :

$$-\frac{d(S)}{dt} = \varkappa R_{abs.} \quad . \ . \ . \ . \ . \ . \ . \ . \ . \ . \quad (17)$$

and

$$\Delta(S) = \int_0^t \varkappa\, R_{abs}\, dt = \varkappa\, R_{abs.}\, t. \quad . \ . \ . \quad (17a)$$

If relation (16) holds (which is probably usually the case) the total amount of solute changed $\Delta(S)$ is independent of its concentration and proportional to the total radiation dose ($R_{abs.}$) as seen from equation (17*a*). Whereas the latter is practically always true, the independence of the concentration depends on whether equation (16) is fulfilled.

The above result is in agreement with the experimental evidence[1], and in particular with Dale's 'dilution effect', that is, the radiochemical deactivation of enzymes is independent of their concentration.

If there are two solutes present, for example, in addition to a substrate S an enzyme E, the primarily formed OH hydroxyl radicals will also react with the latter in a reaction of the same type, namely :

$$E + OH \xrightarrow{k_E} \underset{\text{(deactivation)}}{\text{decomposition products}} \quad . \ . \quad (18)$$

From this, the rate of deactivation of E (for the stationary state) is given by :

$$-\frac{d(E)}{dt} = \frac{\varkappa\, R_{abs}}{1 + k_S[S]/k_E\,[E]}; \quad . \ . \ . \ . \quad (19)$$

that is, the rate of deactivation is *decreased* with increase of the ratio of the concentrations $[S]\big/[E]$. This corresponds to Dale's 'protection effect'[2].

This treatment can easily be extended to the case of several solutes : the reactivity of any particular substance being expressed by the rate constant of its acceptor reaction.

If the hydrogen atoms react instead of the hydroxyl radicals, the situation is obviously quite similar.

Apart from this indirect action of the solute as acceptor towards the radiation products hydrogen atoms or hydroxyl radical, there is, of course, also the possibility of a direct absorption of the radiation by the solute itself followed by some chemical change.

Any photochemical or chemical primary process in solution consists in either the removal or the transfer of an electron, and these processes constitute the two general types of chemical elementary processes (oxidation and reduction). Whether these processes are induced directly by the radiation or through reactions with hydroxyl radicals (oxidizing, electron acceptor) or hydrogen atoms (reducing, electron donor) makes no difference for the final result.

This conclusion is fully borne out by a consideration of those solutes of which the photochemistry is fully known, as is the case, for example, for the simple inorganic ions[15] which have been discussed above. A closer study shows that in these cases it would make no difference for the end effect whether the radiation acts directly on the solute or indirectly through the primary decomposition products of the water. It is obvious that this fact alone would make the radiochemical change independent of the concentration in the case of one solute.

In aqueous solutions it may be said that, in general, whether the action of the radiation on the solute is

either direct or indirect, there will be no appreciable difference in the qualitative result of the radio-chemical process. However, the difference in the quantitative result may be of great importance from a biological point of view*. Furthermore, it is clear that the general principles outlined above can also be applied to non-aqueous solutions.

* This was very kindly pointed out to me by Dr. W M Dale.

[1] Allsopp, *Trans. Faraday Soc.*, **40**, 79 (1944), where a full bibliography will be found.
[2] Dale, Meredith, Tweedie, NATURE, **151**, 280 (1943). Dale, *Biochem. J.*, **34**, 1367 (1940); **36**, 80 (1942); *J. Physiol.*, **102**, 50 (1943); *Brit. J. Rad.*, **16**, 171 (1943).
[3] Eyring, Hirschfelder and Taylor, *J. Chem. Phys.*, **4**, 479 (1936).
[4] Risse, *Ergebn. Physiologie*, **30**, 242 (1930).
[5] cf. Fricke, Cold Spring Harbor Sympos., **2**, 241 (1934)
[6] Arends and Ley, *Z. physik. Chem.*, **6**, 240 (1929).
[7] Franck and Haber, *Sitz. Preuss. Akad. Wiss.*, 250 (1931).
[8] Franck and Rabinovitch, *Trans. Faraday Soc.*, **29**, 120 (1933).
[9] cf. Weiss, *Trans. Faraday Soc.*, **31**, 668 (1935).
[10] Haber and Weiss, *Proc. Roy. Soc.*, A, **147**, 332 (1934). Weiss, *Trans. Faraday Soc.*, **31**, 1547 (1935).
[11] Kailan, *Z. physik. Chem.*, **98**, 474 (1921).
[12] Lanning and Lind, *J. Phys. Chem.*, **42**, 1229 (1938).
[13] Fricke and Hart, *J. Chem. Phys.*, **3**, 60 (1935).
[14] Clark and Coe, *J. Chem. Phys.*, **5**, 97 (1937).
[15] cf. Weiss, *Trans. Faraday Soc.*, **37**, 463 (1941).

FREEDOM FROM WANT OF FOOD

A PUBLIC conference on "Freedom from Want of Food" was organized by the Watford branch of the Association of Scientific Workers and other local bodies on May 20 to discuss the findings of the United Nations Conference on Food and Agriculture held at Hot Springs, Virginia, last year.

Sir Jack Drummond, of the Ministry of Food, who was one of Great Britain's delegates to Hot Springs, described that meeting as the first conference of the peace. It was concerned with the international planning of the production and distribution of food. Forty-four nations were represented and there were scarcely any conflicting views among the delegates. Scientific men considered how their knowledge of nutrition could be applied to the vast problem of malnutrition; agriculturalists considered how best to produce the vast quantities of food the world requires for the adequate nutrition of all; economists considered how the world's trade could be planned to facilitate the most efficient production and distribution of food. Finally, the findings of these several groups was co-ordinated into the United Nations plan for securing 'Freedom from Want'. By international agreement and planning the nations were to produce and distribute food on the basis of physiological requirements.

The problem, Sir Jack said, is terrifying in its magnitude. For example, in culturally backward countries, better nutrition would result in a vastly better survival-rate of children. Hence populations already numerous would only add to their number and thus aggravate the already terrible problem of adequate food supply. In Britain we have made a start in the rationalization of food distribution. Milk was in short supply in the winter now not because it is being produced in lower quantities than before the War. Actually far more milk is being produced, but it is being allocated to those who need it most —nursing mothers and children. Food—the right kind of food—is now regarded as a very important part of preventive medicine. Medical men are becoming more and more interested in how to prevent disease rather than merely how to cure it. Nutritious food is a great preventative of illness.

Mr. P. Lamartine Yates said that four things are necessary in order that practical results should come out of the deliberations at Hot Springs. First, there must be constant surveys into the state of the nutrition of the people and inquiry into what foods are being eaten. Since the War, the Ministry of Food has made surveys and so has its opposite number in the United States. As a result, a great deal of information on diet and nutrition has become available. These surveys must continue after the War if malnutrition is to be avoided. Secondly, propaganda such as that started by the Ministry of Food to show people what they ought to eat and how they can get the best out of their food should be continued and extended. Thirdly, there must be a stable relationship between wages and the cost of food. Poverty is the basis of malnutrition and at present food prices are being kept down by means of a Government subsidy of £200 million a year; this is at 2*s.* a person a week. While Mr. Yates is not in favour of the continuance of such vast subsidies after the War, he thinks that wages and food prices should fluctuate together.

Finally, Mr. Yates urged that someone must be responsible for looking after all this. The United Nations are setting up a permanent international committee in Washington; but on a national scale Mr. Yates believes that a Ministry of Food will still be necessary. We are in for a grim time after the War. Shipping is short and because labour all over the world is engaged in war production there is a world food shortage. Only with difficulty will the United Nations obtain sufficient food to alleviate the worst sufferings of a battered and starving Europe. We must be prepared to put up with rationing of our basic food for a year or two after the War.

There followed a lively discussion and several important points were raised from the floor.

The Conference unanimously adopted a resolution urging that similar conferences should be organized in other parts of Britain to make known to the public the resolutions passed at the Hot Springs Conference. The necessity was accepted for continued rationing of food in Great Britain until such time as the population of Europe is ensured of adequate nourishment, and it was resolved that the administration of relief to enemy occupied countries should not be used either directly or indirectly as a means of exerting political pressure upon the populations concerned.

FOOD PRODUCTION IN INDIA

IN his presidential address to the Section of Agriculture at the thirty-first Indian Science Congress, Rao Bahadur Dr. D. V. Bal presented certain aspects of the present and post-war food production in India.

One of the paramount needs of India at the present time is to lessen the gap between the food produced in the country and the amount required to feed the population adequately. Before the War, home production fell far short of requirements and 2–2·6 million tons were imported annually. The population of India is now much larger than it was a few years ago, but the increase in the area under food crops and normal yields have not been proportionate to the increase in population. The resultant food shortage and occasional famines indicate the urgency of

the need to make India self-sufficient for food, instead of relying more and more upon imports.

To effect this, many factors require consideration, and State aid in various directions is essential. Water shortage can be mitigated by irrigation facilities and by the construction of wells in certain areas. Low yields are often due to the selection of unsuitable types of soil for certain crops. Surveys need to be undertaken to adjust this problem, and to determine where poor arable land would be more profitable if it were laid down to pasture or trees. Soil fertility can be improved by raising the organic matter status by encouraging the preparation of composts from farm wastes, town refuse and night soil. Rotation of crops, including the cultivation of legumes, would serve the double purpose of providing valuable essential foodstuffs and raising the nitrogen content of the soil. The available amount of protein for human consumption is definitely inadequate, and the deficiency can only be made good by extensive growth of leguminous crops.

It is calculated that improvement in the quality of the seed sown would result in an increase of 10–20 per cent of crop, and a great extension of seed farms is called for to produce and distribute improved seeds of various crops. The breaking up of fallow land to increase the arable acreage is not always practicable, owing to the need for maintaining adequate pasturage for cattle, which in India are so important as beasts of burden as well as for milk production. Serious attempts are being made to improve the cattle by better methods of breeding, and a necessary corollary to this is a stepping-up of the amount and quality of the available feed. As it is, the existing supplies of fodder and the area under pasture are inadequate, and to avoid the inevitable competition between the utilization of land for human and for cattle food, it is essential for better methods of cultivation and manuring to be adopted in both cases. If this were done, an increase of 25–33 per cent of human food could be produced from the area at present under the plough, while adequate manuring and appropriate systems of grazing would bring about a corresponding improvement in the supplies for cattle.

Very considerable losses occur in stored grain from weevil attack, at least 1·3 million tons a year being damaged by insects. Rats and spoilage by weather cause further loss, and provision is needed for more adequate storage facilities.

If maximum crop production is to be obtained, it will be necessary for the State to play a part by subsidizing the cultivators, in order to encourage them to use modern methods without the fear of financial loss. The more adequate food supplies thus obtained would so improve the health and strength of the workers as to raise the standard of industrial manufacture as well as that of agriculture.

In order to stabilize the production in India of various crops in general, and food crops in particular, it is essential to consider the long-range problems and prepare a co-ordinated plan to make the country a self-sufficient unit. Experiments are necessary to determine the maximum crop-yielding capacities of soils, special attention being given to the organic matter and nitrogen status of the soils. The standard experiments finally fixed should be conducted simultaneously at various places with different soils and climatic conditions. For this purpose an efficiently trained body of workers is essential, partly to carry out the fundamental research and partly to act as propagandists in making the results known to the agriculturists. After the return of personnel and machinery from war purposes, many men can be used to colonize selected areas and to carry out organized campaigns against diseases and pests of crops, involving the use of specialized machinery, insecticides and fungicides. Many war vehicles could likewise be adapted for power work on the farm for many purposes.

Finally, it is realized that a suitable wage system must be evolved, ensuring a basic wage to the agricultural labourers, rising in accordance with increased costs of living. Such a system, together with certain subsidies to the cultivators, would make for financial stability in the agricultural world.

BIOLOGY OF THE PRAWN LEANDER

LITTLE is known in detail of the habits of the prawns of the genus Leander, and Dr. H. Höglund's monograph* fills a distinct gap. It is an excellent work and a model for those dealing with the biology and life-history of a single species of prawn. *Leander squilla* together with the more important *Leander adspersus* forms a fishery on the west coast of Sweden. The researches have been carried out, partly as field investigations in order to study *Leander squilla* as a member of a stock, its habits, propagation, growth, etc., under natural conditions in the sea, partly as aquarium experiments in order to study such individual processes as mating, spawning, hatching and moulting.

During the winter, the prawns inhabit deep water. When the water in the upper layers has become warmed in the spring, they begin to appear on the shores, and breeding takes place throughout the summer. Temperature is shown to be all-important to migration, breeding and growth, and the time of arrival of the prawns on the shores varies in different seasons according to conditions. In the autumn they return to deep water. Unlike *Leander adspersus*, which, according to Mortensen (1897), migrates to deeper and colder water to hatch out the larvæ, *Leander squilla* apparently remains close to shore in shallow water. The newly hatched larvæ occur in the plankton. It is specially to be noted that the larvæ of both the Leander species occupy the upper layers, whereas all the other carid larvæ of the district frequent the deeper water from 15 to 25 metres.

Both males and females become mature during their second summer, when about a year old. Females may produce two broods in one summer. Larger and older prawns are scarce, but these avoid the nets much more successfully and there is evidence that they may live for three years.

Striking film photographs are given of the pairing, moulting and spawning processes taken in aquaria. The armature of the female thorax and pleopods in the breeding season ("the breeding dress") is very fully investigated and the exact function of each batch of setæ is determined. Most of these setæ are for use only when the eggs are extruded, appearing at the moult preceding spawning and disappearing after the last batch of eggs has hatched out, when another moult takes place.

* "On the Biology and Larval Development of *Leander squilla* (L.) forma *typica* de Man." By Hans Höglund. *Svenska Hydrografisk-Biologiska Kommissionens Skrifter*, Ny Serie, Biologi, **2**, No. 6 (Stockholm, 1943).

The larvæ of *Leander squilla* forma *typica* are described in detail and closely resemble those of *L. adspersus*, although the colour is quite different. Five or six larval stages are recognized, the last stage changing to post-larva. The larval characters of the two species are compared in a table. The whole planktonic larval period lasts for about four weeks, after which the post-larvæ make their way to the shores. This they do very quickly, often before another moult takes place, and the young prawns appear on the shores in enormous quantities.

The illustrations throughout are very good, including clear outline figures in text and plates. The photographic film figures are very illuminating.

FORTHCOMING EVENTS

Saturday, June 17

BIOCHEMICAL SOCIETY (in the Physiology Department, University College, Dundee), at 2 p.m.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2 p.m.—Mr. H. R. Wheeler: "American System of Coal Mining"; Messrs. R. Williams, W. Jeffery and A. Taylor: "Outbursts of Gas from the Floor of Coal Seams", Part 1.

Monday, June 19

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Annual General Meeting.

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Institution of Mechanical Engineers, Storey's Gate, St James's Park, London, S.W.1), at 7.15 p.m. —Prof. P. H. Gross: "Planning and Education for Technical Research".

Tuesday, June 20

SCIENTIFIC INSTRUMENT MANUFACTURERS' ASSOCIATION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 1 p.m.—Luncheon Meeting. Mr. J. Chuter Ede, D.L., M.P.: "Technical Education".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. R. J. E. Silvey: "Listener Research".

Wednesday, June 21

ROYAL SOCIETY OF MEDICINE (joint meeting of the SECTION OF COMPARATIVE MEDICINE with the INSTITUTE FOR THE STUDY OF ANIMAL BEHAVIOUR) (at 1 Wimpole Street, London, W.1), at 2.30 p.m. —Dr. C. S. Myers, F.R.S.: "Instinct"; Dr. W. H. Thorpe: "Learning Processes in Animals"; Prof. D. B. Johnstone-Wallace: "Grazing Habits of Beef Cattle"; Dr. Arthur Walton: "Comparative Sexual Behaviour in the Male".

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 3 p.m.—Scientific Papers.

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 4.30 p.m.—Mr. N. Carruthers: "A Simple Periodoscope for Meteorological Data". Dr. T. E. Allibone: "Multiple Lightning Strokes".

ZOOLOGICAL SOCIETY OF LONDON (at Regent's Park, London, N.W.8), at 4.30 p.m.—Exhibition of a Cinematograph Film of some Animals taken in the Society's Gardens, with Commentary by Dr. Edward Hindle, F.R.S.; Mr. Michael Pease: "The Cambridge Auto-sexing Poultry Breeds".

Saturday, June 24

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (joint meeting with the SCIENTIFIC FILMS ASSOCIATION) (at the Large Theatre, Ministry of Information, Malet Street, London, W.C.1), at 3 p.m.—Discussion on "The Construction and Presentation of Scientific Films". (Mr. Arthur Elton: "The Scope and Distribution of Scientific Films"; Mr. Geoffrey Bell: "Shooting Scientific Films"; Dr. J. Yule Bogue: "The Production of Scientific Films for Medical and Biological Purposes".)

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER IN ENGINEERING in West Africa—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.836A) (June 21).

PHYSICIST for essential War work (work would include experience in various research departments of a North London firm specializing in optical instruments for scientific and industrial research and control)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. A.518XA) (June 21).

LECTURER (woman, resident) in BIOLOGY at the Cheshire County Training College, Crewe (for Women students)—The Director of Education, County Education Offices, City Road, Chester (June 22).

GRADUATE LECTURER IN GENERAL SCIENCE—The Principal, Derby Technical College, Normanton Road, Derby (June 23).

LECTURER IN ELECTRICAL MACHINERY in the Department of Electrical Engineering—The Registrar, King's College, Newcastle-upon-Tyne 2 (June 24).

TEACHER (full-time) OF GENERAL SCIENCE with qualifications in PHYSICS and CHEMISTRY, in the Junior Technical School of Oldham Municipal Technical College—The Director of Education, Education Offices, Oldham (June 24).

ASSISTANT MASTER to take ENGINEERING SUBJECTS (Mechanical or Electrical), with subsidiary Mathematics or Drawing, an ASSISTANT MASTER to take PRODUCTION ENGINEERING Subjects, with Workshop Practice, and an ASSISTANT MASTER to take MATHEMATICS and SCIENCE, with subsidiary Drawing—The Principal, Enfield Technical College, Queensway, Enfield, Middlesex (June 24).

MASTER or MISTRESS to teach MATHEMATICS in the Mid-Essex Technical College—Mr. E. W. Alston, Education Office, Mid-Essex Technical College, Chelmsford (June 24).

PSYCHIATRIC SOCIAL WORKER with qualifications in SOCIAL SCIENCE and MENTAL HEALTH—The Director of Education, Education Offices, Middlesbrough (June 24).

EDUCATIONAL PSYCHOLOGIST (man or woman)—The Director of Education, Education Offices, Wolverhampton (June 24)

AGRICULTURAL CHEMIST—The Director of Agriculture, School of Agriculture, Houghall, Durham (June 24).

HORTICULTURAL ASSISTANT (temporary, male or female)—The Clerk to the County Council, County Offices, Sleaford, Lincs. (June 24).

LECTURER IN MECHANICAL ENGINEERING, and a LECTURER IN MATHEMATICS, in the Denbighshire Technical College—The Director of Education, Education Offices, Ruthin, Denbighshire (June 26).

LECTURER (temporary) IN MATHEMATICS—The Registrar, King's College, Newcastle-upon-Tyne 2 (June 26).

ENGINEER AND WORKS MANAGER of the Great Berkhamsted Waterworks Undertaking—The Acting Secretary, Great Berkhamsted Waterworks Co., 166 High Street, Berkhamsted (June 30).

SENIOR LECTURER IN SCIENCE with Graduate or equivalent qualifications in PHYSICS and CHEMISTRY, in the Ipswich School of Technology —The Secretary for Education, 17 Tower Street, Ipswich (June 30).

COMBUSTION AND RESEARCH ENGINEER by large organization, with headquarters at Glasgow—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2031XA) (July 1).

ASSISTANT LECTURER IN ENGINEERING—The Registrar, The University, Manchester 13 (July 1).

MECHANICAL ENGINEER (with general experience and good Degree) for Research and Development in Steel Tube Industry (Midlands)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2162XA) (July 3).

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No E.902A), and a JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E. 903A), by the Sierra Leone Government —The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting appropriate Reference No.) (July 5).

EXECUTIVE ENGINEER by the Sierra Leone Government—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.1011A) (July 5).

TECHNICAL CHEMIST (Reference No. F.2012XA) and a LABORATORY ASSISTANT (Reference No. F.2503XA), by London Paint Manufacturers —The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting appropriate Reference No.) (July 8).

ASSISTANT SECRETARY to the Oxford and Cambridge Schools Examination Board—The Chairman of the Oxford Delegacy, St. Catherine's Building, St. Aldate's, Oxford (July 31).

READERSHIP IN PHYSICAL ANTHROPOLOGY—The Registrar, University Registry, Oxford (August 31).

ASSISTANT LECTURER (Grade III) IN THE DEPARTMENT OF ORGANIC CHEMISTRY—The Registrar, The University, Liverpool.

PSYCHIATRIC SOCIAL WORKER (full-time)—The Secretary, Education Office, Trinity Street, Colchester.

TEACHER OF MATHEMATICS AND PHYSICS in the Handsworth Technical College and Junior Technical School—The Principal, Handsworth Technical College, Golds Hill Road, Birmingham 21.

TEACHER OF SCIENCE (particularly CHEMISTRY) AND MATHEMATICS, and a TEACHER OF MATHEMATICS AND ENGINEERING SUBJECTS, in the Slough Junior Technical and Commercial School—The Secretary for Education, County Offices, Aylesbury, Bucks.

GRADUATE LECTURER IN SCIENCE AND MATHEMATICS—The Clerk to the Governors, Technical College, Chesterfield.

TEACHER (temporary) OF CHEMISTRY and/or PHYSICS, with subsidiary MATHEMATICS, in the Swansea Technical College—The Director of Education, Education Department, Guildhall, Swansea.

GRADUATE IN PHYSICS, a GRADUATE to teach ELEMENTARY MATHEMATICS and SCIENCE, mainly for work in the Day Technical School for Boys and part-time Day Classes, and a GRADUATE to teach SCIENCE, mainly BIOLOGY, mainly for work in the Day Technical School for Girls, of the Maidstone Technical Institute—The District Secretary of the Kent Education Committee, Mr. A. W. Peacock, 13 Tonbridge Road, Maidstone.

PSYCHIATRIC SOCIAL WORKER (full-time)—The School Medical Officer, Public Health Department, County Hall, Maidstone.

RESEARCH PROFESSORSHIP IN ANIMAL HEALTH—The Principal, University College of Wales, Aberystwyth.

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TRAINING OF METALLURGISTS

A CONSIDERABLE amount of attention is being given at the present time to the general problems of education and training in Great Britain, and various groups such as the physicists, chemists, etc., have been reviewing existing arrangements for their professions. Recently, the subject of the supply, training and status of metallurgists has been examined by the Council of the Iron and Steel Institute, and a report giving its conclusions has been issued*. Although the Iron and Steel Institute as a body is primarily concerned with ferrous metallurgy, many of the recommendations given in the report will be found to apply to metallurgists destined for the non-ferrous industry. The report is a comprehensive one, and will be of value to all those concerned with the recruitment of metallurgists and with their employment in industry.

A severe shortage of trained metallurgists is expected at the end of the War. Various factors have contributed to this. The science of metallurgy is relatively new ; one may recall that the primary principles involved in the heat-treatment of carbon steels were still a subject of debate at the close of the War of 1914–18, and it is only during the period between the Wars that the metallurgist, as distinct from the chemist, has won real status in industry. Coupled with this possible lack of appreciation, both the demand and the supply has been limited by the severe depressions to which the industry has been subjected. Meanwhile, great progress has been made in steel-making processes, in the development of new and stronger materials, etc., and changes in technique which involve the employment of more highly trained metallurgists. It is envisaged that continued technical development will be necessary if British industry is to thrive in the highly competitive markets of the post-war period, and thus a still higher proportion of trained men will be required.

To cope with the expected shortage, the following steps are recommended to stimulate recruitment : direct contact with schools, attractive initial salaries, good prospects, etc. It is surprising how little information the average schoolboy receives which in any way interests him in metallurgy, and consequently, except for the districts where metallurgical industries are located, a metallurgical career seldom receives consideration. Publicity of the right type will undoubtedly cure this ; but to produce permanent effects, remuneration and prospects will be expected comparable with those in other professions, and adequate to eliminate concern regarding the violent depressions suffered periodically by the industry.

The report considers the training of personnel under three main headings : university training, education below university standard, and adult training. For the university trained man, it recommends that the degree course should be divided into two parts. The first should be directed to higher study of the basic scientific subjects, physics,

* The Training of Metallurgists, with Special Reference to the Iron and Steel Industries. Pp. 32. (Iron and Steel Institute, 4 Grosvenor Gardens, London, S.W.1, 1944.) 2*s*. 6*d*.

chemistry, some mathematics, and engineering, and the second to a continuance of study in these fields and to the particular study of metallurgy. This emphasis on a high standard in the basic sciences will no doubt be given appropriate consideration by the university authorities. Great importance is attached to early experience of industrial operations during a university career, and it is suggested that works courses during vacation should form part of every university course. Careful consideration will need to be given to the extent to which such courses can be instituted without leading to 'over training' of the undergraduate.

For the training of process metallurgists, the report concludes that existing facilities are inadequate ; and it is suggested that Great Britain should legislate for training many of the men needed to develop our Empire resources. The primary metal-producing industries throughout the British Empire form a large potential market for British manufactured products, and the development and sale of such products will be facilitated if the personnel in control are British trained.

Once in the works, the training of a graduate should be continued for some years, through arrangements which permit him to work for periods in all the various departments in which he may be particularly interested. This will increase his experience, give him a grounding in the internal administration and enable his employers to form a good idea of any special aptitude he may have. Such training schemes are in progress in some of the larger organizations and are successful. Perhaps insufficient attention has been paid in the past to the latent possibilities in new employees ; thus it sometimes happens that a man is taken on for a specific job, and although he may turn out ultimately to be not specially suited for the particular work concerned, he has to continue with it ; in large organizations there are much greater possibilities for manœuvre in such matters. Employers are recommended to encourage their men to write papers, to join in discussions and pay visits, and generally to participate in the professional activities associated with their particular branch of industry. For the keen man such facilities are well worth while, since they lead to rapid development of a sound critical faculty.

The importance of postgraduate education is not sufficiently emphasized in the report. The report indeed urges the need for improved facilities, and suggests that each university should specialize in some subject appropriate to the local industry. Postgraduate research is likely to be more productive for the individual if it is carried out where there is an active 'school' of research. Under such conditions a man, merely by keeping in touch with his fellows, can get a wide knowledge of research methods, etc., in a very short time. Again, it is essential that the professor should be keenly interested in research and not weighed down with administrative duties and normal teaching. The whole subject of postgraduate research needs reviewing by the authorities, to ensure that research facilities and atmosphere are really satisfactory.

Many of the recruits to industry come direct from school, and will no doubt continue to do so for some time. Their subsequent education takes the form of part-time courses or evening classes, and suggestions for improvement are made, including the institution of courses leading to the award of a national certificate in metallurgy. Such an award would be a desirable objective for the student, and a useful qualification to the employer. The report suggests that industry should encourage part-time education and limit the attendance necessary at evening schools to the absolute minimum.

The position with regard to part-time training should be simplified when the proposal is implemented that all persons who show sufficient ability at school should automatically receive a university training. Then the amount and type of training appropriate to the remainder will be more limited in scope than at present, and may conceivably be carried out by the envisaged young people's colleges or similar institutions. It is most desirable that men with first-class ability should be saved from the onerous task of educating themselves through evening classes and of suffering from "an impoverishment of initiative and intellectual quality at a period of life critical for the full development of the powers and capacities of the individual"*. In the meantime, a broadminded attitude from industry and close collaboration with the universities and technical colleges are necessary to achieve the best results from the promising material that enters industry direct from school.

On the question of adult education, the report mentions the need for refresher courses on specialized subjects for managers and staff, and refers to short courses to be held at universities with residential facilities. The Bristol conferences on metals and the Cambridge crystallographic conferences are successful examples of such meetings held by physicists. Interchange of senior staff between university and industry is considered to be very beneficial ; but no practical methods for achieving such an interchange have yet been put forward. There are obvious difficulties, and various substitutes, such as interchange lectures and visits, probably represent the extent to which such suggestions can be implemented.

The training of workmen either for posts of higher responsibility or to give them better insight into their normal work is considered, and reference made to the outstanding success of the educational efforts of the Sheffield Trades Technical Societies. This organization works in the closest co-operation with the University of Sheffield, where lecture courses are provided "to enable workers to study the commercial and technical side of their work and to receive the latest scientific information which may be applied to their trade". Similar organizations might well be set up in other large manufacturing centres.

Satisfactory operation of all these educational schemes depends to a very large extent on the existence of the requisite number of able teachers ; and, especially in the case of part-time courses and

* See p. 8 of "Industry and Education—a Statement". From Nuffield College. (Oxford University Press, London, 1943.)

evening classes, teachers are required who can make their subject interesting. The report directs attention to an existing shortage of teachers, and suggests that both remuneration and status should be raised so that more men will become available.

Very little advice is offered regarding the selection of men to be trained. This subject should be given serious consideration. All will agree that educational arrangements should be such that every person has facilities readily available appropriate to his abilities. On the other hand, efforts made to train people beyond their capabilities are largely wasted. Many evening school candidates probably fall into this category, and some attempt should be made by means of psychological tests to restrict facilities in technical training to those persons who can benefit.

EDUCATION AND THE WORLD STATE

The World We Mean to Make

And the Part of Education in Making It. By Maxwell Garnett. Pp. 264. (London: Faber and Faber, Ltd., 1943.) 10*s*. 6*d*. net.

IN times of comparatively rapid social change, there tends to be more thinking about education than in periods of comparative quiescence. Those who seek to control the development of society, in whatever aspect of it they are interested, are apt at some stage in their thinking to see in education one of the main forces which can bring about the conditions they desire. This is natural, for one of the chief functions of education is to transmit to the young what the older members of society most value in their culture, as the basis of the new world in which the young will live. Dr. Maxwell Garnett is concerned with the world "during the next two generations", and he adopts Mr. R. A. Butler's dictum that "education is the main arm with which to win the next peace".

Dr. Garnett has a plan for education in England; but to add another to the many plans which have been published during the last few years is not the primary purpose of his book. It has been a weakness of recent planning in education that the aims of education have not usually been thought about enough or expressed explicitly enough, and with the ends obscure it has been difficult to evaluate the means proposed. It is a great merit of Dr. Garnett's book that he presents a reasoned statement of the functions and processes of education as he sees them. His aims in education are an integral part of a philosophy, and the means he proposes take cognizance of political and social trends and the evidence of psychology. Not all will agree with his philosophy or with his view of the facts, but they do constitute reasoned position which is both tenable and arguable.

A few sentences may summarize Dr. Garnett's position, though it cannot do justice to the wide range of his information and his thinking. The War should be followed by a general settlement, based upon the Atlantic Charter and President Roosevelt's four freedoms, which should bring into being an international authority, the Commonwealth of United Nations. This Society of States should promote human welfare, and should maintain the rule of right by administering international law. It should have at its command the sanction of armed force. But the Commonwealth cannot be maintained merely by the fear of power: it must depend on the enlightened loyalty of its citizens and their will to serve its purposes. Enlightenment by itself will not serve: " 'The mere intellect', wrote Aristotle, 'has no motive power' ". Free will, "something from outside space and time", "a spirit which can alter the course of our lives", will play its part, but since such interventions are comparatively rare events we cannot rely too heavily on them. We must in the main depend on the development of a 'sentiment' of loyalty to the Commonwealth as the single wide interest which will move men to act in the ways required. But are the values which the Commonwealth enshrines and which are to command our loyalty true as well as good? They appear in our inner world, "the ordered world pictured by the man with a single wide interest", as desirable ends: does our inner world correspond with the outer world, "the world as it really is, or as it is partially known to science", so that our ends can be regarded as not only good but also true? We do not know. We can only believe, by adopting a hypothesis "beyond the so-called 'discoveries of human reason' ", which we may find among "the essentially similar 'divine revelations' ". Most of the seven or eight great religions of the world offer the hypothesis that the supreme good is also the supreme reality. The Commonwealth, which must depend on the loyalty of its citizens, should therefore foster religious education. In Great Britain this means Christian education. The aims of education in England may be summed up as Christian faith, political loyalty and economic efficiency.

This is not a novel position. Dr. Garnett himself relates his ideal to that of Dr. Arnold a hundred years ago, to train Christian gentlemen. It is probably the position of a majority of those in Great Britain who are articulate about education. The plan for education which Dr. Garnett bases on it is accordingly not a revolutionary one. It resembles in many of its details the proposals of the Education Bill, which itself represents the highest common factor in the attitudes of those who have power to legislate for education. Dr. Garnett wants, for example, grammar schools, technical schools and modern schools, with some experiments in multilateral schooling. He finds good reasons why compulsory attendance should cease at fifteen rather than sixteen. He wants attendance at young people's colleges on one day a week. His plan need cause no alarm or despondency among the supporters of preparatory schools, public schools, direct grant schools, or the Oxford and Cambridge open scholarship system. He does not hesitate to apply to the schools the hypothesis he has adopted about religious truth. For example, "Local education authorities or managers will have to choose the head teachers of their primary schools from among those members of the profession who are zealous for Christian education". He refers, of course, to rights of conscience. "This practice should not be enforced by law. This is eminently a case for Plato's 'victory of persuasion over force' ". The appointing body would merely ask the prospective head-teacher certain questions, and "A candidate who gave no adequate answers to these questions or to others of the same sort would not be appointed as head teacher". In certain directions, such as adult education and the regional organization of educational administration, Dr.

Garnett would go further than Mr. Butler in his agreed measure has proposed to do. But in general, Mr. Butler could congratulate himself on finding respectable philosophical warrant for his Bill in Dr. Garnett's book, and Dr. Garnett could reflect with satisfaction that his theory of education is capable of translation into the realistic terms of administrative legislation. Their new education will be cast in the image of the old, but will undoubtedly be in many respects an improved version.

It is well that those who hope to fashion the shape of things to come should in this way draw on the wisdom that tradition and their own experience have given them. They cannot do more. Dr. Garnett's book, with its orderly argument and copious use of evidence, will help them to see their own way ahead. New generations, however, will have new experience and will interpret it in their own way. The world we mean to make will not necessarily be the world the next generations will see fit to make.

R. A. C. OLIVER.

UTILITARIAN ASPECTS OF GEOLOGY

Geology in the Service of Man

By Prof. W. G. Fearnsides and Dr. O. M. B. Bulman. (Pelican Books, A.128.) Pp. 158+8 plates. (Harmondsworth and New York: Penguin Books, Ltd., 1944.) 9*d*. net.

NOT so very long ago, the layman who wanted a simply written and up-to-date book on geology would have had to be content with a students' primer not altogether suitable for his needs. Now some half-dozen small volumes, written especially for him, await his choice; and among them this new "Pelican" book takes a high place. The authors have set out to show how geology has been used in the service of man—when he has been wise enough to utilize such knowledge—and have made clear their purpose in writing the book by their introductory note: "It is regrettable that more geologists have not been professionally associated with the war effort; it will be a tragedy if geological knowledge is not co-ordinated and directly applied in post-war reconstruction".

The book is divided into two parts, the earlier being a brief account of geological principles, an acquaintance with which is necessary for the appreciation of the later part, which is a review of the economic aspects of the science. In Part 1 the manner of treatment followed by the authors is what might be termed the 'classical' method; that is, it begins with the consideration of the earth as a globe, and the composition and physical properties of its core and crust, as elucidated by geophysical and chemical investigations. Whether or not this is a better approach for a layman than one which begins with the phenomena and materials around him—and therefore more or less familiar—and leads him to the less familiar and unknown is obviously a matter of opinion. In the present instance, however, the course taken lands him, in about six pages, in a discussion of stability relationships of mineral constituents that may deter him from going farther—which would be a pity since the problem cannot be treated with sufficient accuracy and detail to satisfy the critics, and since it appears that at the moment work on these lines has proved of limited value in petrology. If the reader skims this chapter and passes to those on the building of continents, the development of scenery and the geological history of Britain, he should feel well repaid by following a fascinating story simply told.

A short chapter on the nature and construction of geological maps concludes Part 1. Here, just enough is said to titillate the curiosity of the intelligent reader and make him wish for more, but (most importantly) enough to show that there is a more or less simple geometrical arrangement of the rocks of the crust and not a higgledy-piggledy mess as the uninitiated still seem to think.

Part 2 contains seven chapters, each dealing with an important aspect of industrial geology, such as water supply, geology and soils, petroleum, engineering geology (foundations, reservoirs, tunnels, building materials and roadstones), mineral supplies for heavy industries (coal and iron ores), non-ferrous metals and chemical supplies, and gemstones. Here, indeed, is a wealth of information to satisfy the inquirer; and, considering the scope of the subject-matter, it is noteworthy that the treatment is accurate and up to date throughout.

It may be serviceable to direct attention to a small point of nomenclature. Whereas the terms 'well-graded' and 'well-sorted' were formerly synonymous in geological writing, the practice of engineers is now to apply the former expression to a sediment in which the grains are distributed fairly evenly throughout the grades (as defined by size-limits)—that is, 'well-graded' becomes just the reverse of 'well-sorted' (where most of the grains belong to one size grade). In the interests of conformity and in order to make effective use of two good words, it would be well (at least in my opinion) for geologists to follow the engineers' practice.

To compress a large part of a text-book of geology into a "Pelican" book of 150 pages is no mean achievement. Inevitably it has necessitated a condensed style, but clarity is helped by many diagrams and a number of photographic illustrations. We may hope that the subject-matter will not prove so solid as to be indigestible to the general reader; and, if we can judge from the popularity of other "Pelican" books, certainly not less condensed and even more technical, it should not do so. As it takes two to make a bargain, it would seem that the layman, as well as the man of science, is now playing his part in helping forward this method of disseminating knowledge.

P. G. H. BOSWELL.

WEATHER WISDOM

Weatherwise

England's Weather through the Past Thirty Years. By John H. Willis. Pp. 110+30 plates. (London: George Allen and Unwin, Ltd., 1944.) 7*s*. 6*d*. net.

MR. JOHN H. WILLIS is a member of the band of amateur meteorologists who co-operate with the Meteorological Office in maintaining local records of weather according to a fixed plan day by day and year by year. The climatology of Great Britain owes much to their efforts, which are purely voluntary. It will easily be realized that to carry out such a self-imposed duty successfully, a man must be an 'amateur' in the literal sense of the term. Observations must be made in all weathers; they must take priority over personal convenience, they must be made punctually and they must be meticulously

recorded. So much is stated in the official pamphlet of 'requirements'. Here we may go further and say that the observer must have a real love of Nature, as expressed in the changes of weather. The daily reading of the instruments must not be merely a task to be done; it must be something which he loves to do, and which he approaches with a sense of adventure.

Mr. Willis's pleasant little book is the product of this attitude of mind, a sort of cavalcade of the years and the seasons as they presented themselves during a period of thirty years to an interested onlooker. Starting with the year 1913, we have a summary, on the scale of four or five pages to each year, of what the weather was like at Southwell Lodge, Norwich, with such few actual figures as are necessary to give precision to the verbal picture. In style, the author inclines to the poetic rather than to the scientific, "—a queenly June ascended her throne, to banish from her realm a measure of the month's rainfall, and dower the period of her reign with an additional hour of daily sunshine" (1914). A trifle 'twopence coloured' perhaps, but it is well to remember that a sequence of 'penny plain' statements like "June was dry and sunny" can be deadly dull.

Here and there the story is interlarded with snippets of meteorological theory, not all of which will find favour among the professionals. There are some remarks, too, about popular weather maxims. One of these calls for comment. Speaking of February 1920, Mr. Willis says: "its negligible rains belied once again its cognomen of Filldyke February; . . . according to my own station's records, Filldyke February is the driest month of the year". The matter cannot be so casually dismissed. The cognomen is "fill dyke", not "fill raingauge", and the distinction is an important one. The water seen in a dyke represents drainage from the land, and this is determined not only by the rainfall, but also by evaporation and the state of the soil. The latter factor depends on past rainfall as well as present rainfall. Under the conditions of rainfall and evaporation normally prevailing in Great Britain, the flow of streams and the level of underground water reach a maximum in late winter. There is, in fact, no month of the year to which the cognomen 'fill-dyke' could be more justly applied than to February.

The text is followed by a very interesting collection of photographs. It was a singularly happy idea of Mr. Willis's to photograph the same clump of snowdrops on January 1 every year, as an index of the state of vegetation—and a plant is a good indicator of integrated weather. The procedure was extended to other plant subjects and other dates, and several series of photographs are here reproduced. It is interesting to look at these pictures in conjunction with the table of monthly mean temperature on p. 106. They illustrate the effect of warmth during winter and early spring very forcibly and graphically.

The chronological form of presentation gives this book a very definite value. In times of peace a vast mass of meteorological information is published, but it is not always easy for an inquirer to find what he wants. What was the year of the great Christmas snowstorm? What was the date of the famous display of the aurora a few years ago? Questions of this sort can be answered more readily by reference to Mr. Willis's book and its index than by any other means known to the present reviewer. If for no other reason than this, it is well worth possessing.

E. G. BILHAM.

ARABLE FARMING ON POOR LAND

The Economics of Poor Land Arable Farming
Based on Surveys of Difficult Farming Areas in the East Midlands. By Dr. S. M. Makings. Pp. viii+280. (London: Edward Arnold & Co., 1944.) 18*s*. net.

EVERYONE must have been aware that all was not well with farming in the years between the Wars, but while the complaints of farmers were widely heard, there were few even in agricultural circles who had access to the full facts of the situation. The main problem is to be found among those who are committed to the poorer soils. With this in view, Dr. Makings has made a special study of the economics of certain poor land areas in the East Midland Province of England. In his work in the Economics Department at the Midland Agricultural College, he had access to the records and, so far as they existed, the accounts of a large number of farms in depressed areas. This material forms the basis of the book; it has been sifted and tabulated to give a clear picture of the business aspect of a cross-section of poor land arable farming, and the picture is none too bright. The conclusion is that under the conditions prevailing before the War, and in spite of a measure of government assistance, many farmers in these chosen areas, and particularly those handling the smaller units, were losing money.

The three districts chosen for the survey each suffered from certain definite soil, climatic or special limitations that made for low level of output, and greatly increased the risks that are inherent in production based on living things. In the Sherwood Forest area of Nottinghamshire, hungry, acid sand and the incidence of spring droughts put a heavy handicap on arable farming; in the poor Wolds of Lincolnshire, the thin poor soil and its exposed situation were the dominating factors; while in the Lincolnshire Carrs of the Ancholme Valley, it was lack of drainage rather than soil poverty that put its stamp on farming. The reader derives a clear picture of farming in each of these districts, partly from apt little summaries of the layout and balance of a number of typical farms, and in more precise terms from financial data derived from groups of farms. The Forest and the Wold both depended on the classical four-course rotation which, so long as sheep and barley prices were maintained, was probably the best system for these lands, but in recent years it has become clear that some fundamental change was necessary, and the author sets out the financial results of some of the alternatives that have been forced on the occupiers of these depressed areas.

The question is not entirely one of soil, although it is shown that farmers on better land can intensify and diversify their enterprises much better than their less fortunate neighbours. All the factors that enter the problem are discussed—land tenure, capitalization, and the technical qualifications of the occupiers. Finally, there is the national aspect of the farming of marginal land, not so much as it exists in war-time, but as it will appear after the War with even more land in this uncertain position than we had before. Two preliminary chapters set out the economic background to the detailed study, and a final chapter presents the main conclusions. The book is a thoughtful contribution to an important subject.

THE LAWS OF NATURE*

By PROF. HERBERT DINGLE
Imperial College of Science and Technology

Contrast in Character of Motion and Temperature Laws

IT would, however, be premature to conclude that because the laws of temperature in this one respect follow more closely the outlines of bare experience, they are therefore necessarily purer or more worthy of preservation than the laws of motion. We must look more closely into the matter, for it may be that, when the necessary supplementary clauses, so to speak, have been added, the type of law which has been constructed to describe motions is, by its greater scope, more adaptable to further experiences than the type constructed to describe temperature changes.

To examine this point we may usefully return to our examples of a ball thrown into the air and bodies at different temperatures placed near one another, to see how the difference of description, not inherent in the essential experiences, is introduced in the chosen terms of expression. The ball, it will be remembered, could, and in fact did, reverse its path, while the temperatures of the two bodies moved only towards equality. How did this come about ?

'Bare experience' would have required the ball only to fall, for its tendency is to move towards the earth. Hence something must have interfered with its natural behaviour, and, in fact, we did throw it up, thereby making it take a path it would not by itself have chosen. In order to describe its motion completely, therefore, we must state not only the law of motion but also the initial occurrence which set it moving. No importance is to be attached to the fact that this was a human interference with natural processes, for the same thing might have happened without human agency ; for example, the ball might have been thrown up by a volcano. The essential fact is that the motion cannot be described by the law of motion alone, but needs the statement of the law of motion plus a particular event. According to the character of this event the motion can be in one direction or in the opposite one, and the law of motion by itself must therefore be broad enough to allow both possibilities if it is to cover all the motions that occur in Nature.

The same thing is true, of course, on the larger scale. The planets might have revolved round the sun in the opposite direction so far as the laws of motion are concerned. To explain why they move in the direction observed we must know something of the origin of the solar system. When the circumstances in which they became detached from the sun are known, their motion is completely determined by the laws of motion, and no room is left for the possibility that they might have moved differently. The laws of motion thus establish their freedom by shifting the onus of distinguishing between opposite courses on to the shoulders of a 'boundary condition' ; and when we deal with something so vast and ancient as the universe, this boundary condition lies so far in the past that we are apt to forget that it is there. Consequently we think that the course of development of the universe has the same freedom as the untrammelled laws of motion. In that, however, we are wrong. So far from releasing us from difficulties concerning the origin of things, the laws of motion make it essential that we shall face those difficulties, for they are framed in such a way that otherwise their requirements are necessarily ambiguous.

Now so far as possibilities are concerned, temperature phenomena are in precisely the same boat as the phenomena of motion. In saying that the ball could move up or down whereas the two bodies could only tend towards equality of temperature, I was in fact making an incorrect statement, and if you did not notice it, that is only an indication of our extreme susceptibility to error through accepting laws of Nature as equivalent to bare experience. It is quite possible for the hot body to become hotter and the cold body colder if we choose our initial circumstances properly. For example, a gas expanding suddenly may cool and give its heat to another gas originally hotter. Such circumstances occur much less readily on the earth than do movements against gravity, and we are therefore liable to overlook their possibility. But in principle there is no difference at all in this respect between motion and temperature exchange, and there is no fundamental reason why laws of temperature should not have been constructed permitting a reversible exchange of temperature and requiring supplementary boundary conditions to determine what would happen in a particular case. If that had been done, there would have been no formal difference between the modes of treatment of the two phenomena, and I should have had to choose another subject for this lecture.

It has not been done, however. Perhaps owing in some measure to the fact that in everyday experience the temporary flow of heat against a temperature gradient generally needs the establishment of highly artificial conditions, while the temporary movement of bodies against gravitation is a very common occurrence, a different approach to the problem has been made ; and instead of describing a thermal phenomenon in terms of the rate of change of temperature with time, as we describe a kinematical phenomenon in terms of the rate of change of position with time, we describe it in terms of a new conception, *entropy*, which has no analogue in the present formulation of mechanical laws. The characteristic of entropy is that, no matter whether heat flows from the hot to the cold or from the cold to the hot body, the entropy at the end is always greater than the entropy at the beginning. (There is, it is true, a theoretical possibility that the entropy may remain unchanged, but in practice that can be ignored, and even theoretically it is impossible for the entropy to decrease.) This statement is true only if the *total* entropy is taken into account—the entropy of the hot and cold bodies and of any other body or system which has any influence at all on the process.

By this device we give direct and immediate expression to the one-way tendency of bare experience. We do not need first to give phenomena a round-trip ticket, and then to limit its validity to one direction only according to the ticket office at which it is presented. Whatever happens, whether bodies tread the natural path of temperature equalization or by violence are forced along the opposite course, the entropy of the whole system increases.

No such function as entropy, I have said, exists in the laws of motion, but there seems no fundamental reason why it should not be derivable. Every incidental motion in the universe contributes in its own measure to the grand one-way march of bare experi-

* Continued from p. 736.

ence, and should not be inherently incapable of representation in terms of an ever-increasing (or ever-decreasing, it does not matter which) function which for the purpose of reference we may call 'motion-entropy'. Motion-entropy would increase when an apple fell to the ground, and it would also increase when we threw our ball upwards—provided, of course, we took into account its change in ourselves and in the earth on which we pressed more heavily when we threw, as well as its change in the ball. If motion-entropy were formulated, we could destroy the formal difference between the laws of motion and those of temperature exchange in another way, by bringing the former into line with the latter, instead of by the reverse process.

On the face of it, this would seem the more desirable thing to do, for a direct expression of experience seems preferable to an indirect one. There is a penalty to pay, however. The conception of entropy is such that it has meaning only with reference to equilibrium conditions. Consider our two bodies again, and let us suppose that at the beginning their temperatures, though different, are steady. We can then evaluate their entropy—relative to an arbitrary zero, it is true, but that is of no importance here. Now let them interact with one another. After the lapse of a certain time their temperatures will have become equal, and then they will remain steady again. We can now again evaluate their entropy, and we find, according to the law, that it is greater than it was before. And that is all that the law can tell us. During the interval between the two steady states we cannot say that the entropy has steadily increased; we cannot, in fact, say anything at all about it, for the conditions essential to its significance do not exist. And since, in actuality, things are never in equilibrium, it follows that, in strict truth, we can never assign a precise entropy value to any actual system of bodies, let alone the whole universe. That is one reason why, as we saw, we could not apply our temperature laws to any system not enclosed within a boundary, for a boundary is necessary, though not sufficient, for equilibrium. Our assumption that our two bodies were originally at steady temperatures was an illegitimate one; there is no known process for keeping them so.

It should be understood that equilibrium here has a perfectly definite meaning, and is not subject to the arbitrariness arising from the possibility of changing our terms of expression. I mentioned earlier that a body at constant temperature could be regarded as an inert mass or as constantly interchanging energy with its surroundings, and that we could choose which form of expression we liked. That is true, but the laws of temperature I am speaking about now—in particular the law that entropy always increases—are framed after we have made our choice, and the choice is such that a state of constant temperature is a state of equilibrium so far as temperature is concerned, and a state of varying temperature is not a state of equilibrium. We cannot satisfy the condition for the significance of entropy by conceptually petrifying into equilibrium whatever state we may be confronted with.

The case again is not improved by the adoption of some physical picture of entropy, such as the very common and very convenient though very dangerous one which relates it to 'organization'. That representation was adopted after the discovery of the significance of entropy, and its validity is entirely dependent on its faithful conformity to the characteristics of entropy regarded as a simple mathematical function of certain thermal quantities. 'Organization' is a term of expression of a term of expression, and as such it has aspects which have no connexion with the facts of experience; it allows us, for example, to assign a precise measure of probability to occurrences which we have no reason to suppose are even possible. We can attach no weight to long-distance extrapolations of a process of disorganization which could not be reached also by extrapolations based on the original meaning of entropy, and we shall therefore not concern ourselves with them.

Strictly speaking, then, the entropy of an actual system can never be determined, but in practice we can often arrange to isolate a system sufficiently well for it to appear to be in equilibrium for a finite length of time, and we can then calculate its entropy. In such cases, in spite of its strict meaninglessness, the conception is extremely useful. We always find that the combined entropy of the system and its surroundings is increased when a change occurs, and our assumption that the entropy of the universe is continuously increasing is based on this fact. Such a conclusion, however, I must repeat, is rigorously a meaningless statement, and can only by courtesy be called an unprovable assumption.

The laws of motion do not suffer from this disability. They enable us to follow our ball throughout the whole duration of its flight, whether it is moving upwards or downwards, and make no demand that the system shall be in equilibrium. They have therefore much to compensate them for their excessive latitudinarianism, and make up by attention to detail what they lack in self-sufficiency.

The result of our analysis, then, is this. Our experience, both of the motions and of the temperature changes of bodies, shows that at present the processes going on in the universe tend in a certain direction and not in the opposite one. We describe this tendency for purposes of precise calculation by choosing terms of expression which form the alphabet of physical laws, and since time is included among these terms of expression, the laws allow us to extrapolate to the distant past and the distant future. The terms we choose for motion, however, differ in character from those which we choose for temperature, in that they lead to a different type of law. The former lead to reversible laws, which describe every detail of the changing process, but leave to an unknown 'original state' the task of determining why the process goes in one direction rather than the opposite one. The temperature laws, on the other hand, indicate the direction of the process without reference to an original state, but cannot be applied unless we can contrive or assume that the system in which we are interested is brought to a condition of equilibrium on two successive occasions: they then require that a certain quantity is greater on the second occasion than on the first, but can tell us nothing about the course from the first to the second condition of equilibrium.

Historical Aspect of the Laws of Temperature

Neither type of law affords grounds for dogmatizing about the distant past or future of the universe, and it is perhaps not altogether profitless to have achieved a realization of even that modest result. It is a matter of some interest to inquire why, when the bare experiences follow such similar lines, we should have chosen laws of such different types for describing them. I suggest the following explanation.

The earliest progress in science was naturally concerned with motion, for that is the phenomenon most easily examined with precise measuring instruments. Our theoretical scale of time measurement, for example, was chosen by assuming a body moving freely in space, and defining equal times as those in which it covered equal distances. A radiating body, such as the sun, might have been chosen instead of a moving body, and equal times defined as those in which it melted equal masses of ice, say, but the practical difficulties would have been greater. A kinematical measure was therefore chosen, *and then applied universally*—in particular, to the description of temperature phenomena when they came to be examined. Temperature thus, from the beginning, inherited terms of expression chosen originally for the analysis of motions instead of developing along its own intrinsic lines.

This procedure was further established by practical needs. We required to know how *work* (a concept belonging to mechanics, the science of motions) could be obtained from heat before we were very far advanced in the study of temperature phenomena themselves, and accordingly the additional terms of expression chosen for the laws of temperature were those found to be best adapted to the description of the transformation of heat into work, and not those best fitted for the study of heat for its own sake. The theoretical temperature scale, for example, was based on the amount of work obtainable from heat, and not on simple thermal effects alone. The result of this unnatural union between the representatives of motion and temperature was the birth of entropy, a quantity which was conceived in order to afford a measure of the availability of heat for transformation into work. Nothing parallel to this, of course, existed in the science of motion, and so no corresponding concept was created there.

It may be argued that this was a fortunate circumstance, and that the thermodynamic conceptions thus originated are more favourable for rapid and permanent progress than pure thermal conceptions would have been. From the point of view of the understanding, apart from the exploitation, of Nature, however, this seems to me very unlikely. Certainly our ultimate aim is to unite the sciences of mechanics and heat, but I think the soundest basis for a satisfactory union would lie in the existence of two strong independent sciences established on similar lines. We have brought about a union long before the science of heat has reached maturity, and so forced on it an unnatural development. The incompatibility between the motion and temperature laws is a result of this, and is not a happy augury for future connubial bliss. I venture to propose a return to first principles, and the creation of an independent science of heat, with concepts and laws of its own.

The obvious starting point is the phenomenon of radiation, for of all the modes of temperature exchange that occur, this is overwhelmingly the most important in the universe as a whole. It is indeed impossible to express how utterly insignificant all other temperature phenomena become when compared with it. To take a single example, the sun, a dwarf star, radiates some 4×10^{33} ergs of energy every second to space. On the other hand, the energy available, through all terrestrial processes—production of fuel, human and animal metabolism, etc.—for transformation into work does not exceed 5×10^{19} ergs per second, and if we suppose one tenth of this to be so converted, we see that the radiation from one dwarf star is about 10^{15}—a thousand million million—times the total terrestrial transformation of heat into work in the same time*. How many times the number of stars equivalent to the sun exceeds the number of planets on which work is artificially produced from heat we do not, of course, know; but, whatever it may be, when we consider that the terms of expression and laws of temperature phenomena have been shaped by this terrestrial 'gnat' and then foisted on the multillions of stellar 'camels' throughout the universe, we begin to realize something of the anomaly which has occurred.

Thermal Relativity

There is, however, another reason why we should —indeed, I would go further and say why we *must*— reform our present treatment of radiation. Progress in the study of motion has in the last generation brought to light a fundamental principle which, it is generally acknowledged, is valid throughout the whole of scientific inquiry, and this principle is violated in our present theory of radiation. I refer to the fundamental justification of the theory of relativity, namely, the principle that our theories should not imply the possibility of observing what is, in fact, inherently unobservable. It was this principle that destroyed the materialistic ether doctrine of the nineteenth century. Motion through the ether eluded observation so consistently as to force acknowledgment of the idea that it was inherently unobservable, whereupon the whole science of kinematics was reformed in such a way as to require that any experiment made to observe such motion must necessarily fail. The only observable motion is motion of one body with respect to another, and accordingly the word 'motion' now carries with it the quality of relativity, so that we cannot speak of it without implying the existence of some locatable frame of reference.

Now absolute radiation is unobservable in precisely the same way as is absolute motion, but while we have dismissed the latter from the terms of expression of motions, we still retain the former among the terms of expression of radiation phenomena. Consider two bodies relatively at rest. We used to say that each had an absolute velocity, v, and that they were relatively at rest because their absolute velocities were equal. We have now discarded the idea of absolute velocities, and associate no motion with the bodies. But consider two bodies at the same temperature. We used to say, and we still say, that each has an absolute temperature, θ, as a result of which it radiates a certain definite amount of energy, and that we do not observe any effects of the radiation because each receives from the other the same amount of energy that it radiates. But this absolute radiation, just like absolute velocity, is essentially unobservable. We should, then, in accordance with our principle, cease to employ it in our theories, and express the laws of radiation in such a form that it has no significance.

This, of course, means a radical reform of the laws of radiation, but I can see no escape from its necessity unless we deny the basic justification of the theory of relativity. When we reflect on the matter, we see other points of resemblance between the sciences of motion and radiation, which, indeed, is not surprising in view of the fundamental parallelism of the bare experiences already pointed out. For example, the

* I am indebted to Sir Alfred Egerton for the data concerning terrestrial processes.

development of the mechanical theory of relativity showed that gravitational and inertial mass, two quantities which, according to the former view, just happened always to be equal, were, in fact, essentially the same thing. In the theory of radiation we have likewise two quantities, radiative power and absorptive power, which similarly just happen always to be equal. We might expect that these two quantities, in a reformulation of the theory of radiation, would also be revealed as the same thing. Again, there is in temperature, as in motion, a limit approachable only asymptotically by material bodies ; we call one the absolute zero of temperature and the other the velocity of light. The fact that in temperature there is only a lower limit, whereas the velocity of light is a limiting velocity for motion in all directions, is merely a characteristic of our method of measurement. We have already seen that a measurement of velocity in terms of the Doppler effect would have given us a finite limit in one direction and an infinite one in the other, and we could equally well choose a scheme of temperature measurement (Kelvin, in fact, at one time proposed such a scheme for his 'absolute' scale) which would place the 'absolute zero' at 'minus infinity'.

I have attempted[4] a re-expression of the phenomena of radiation, along the lines of the relativity treatment of the phenomena of motion, in which temperature is measured in terms of the rate of change with time of some observable characteristic of the radiating body, just as velocity is measured in terms of the rate of change with time of the spatial position of the moving body. The 'observable characteristic' could be the energy radiated by the body, expressed in terms of the readings of a suitably defined instrument, but I have found it more convenient to choose an instrument which records something analogous to the entropy change of the body ; I will denote it by the Greek letter η. That, however, is a detail ; the important thing for our present purpose is that temperature is measured in terms of a temporal process instead of by the reading of a thermometer in equilibrium, and the measurement of time involved is made by a thermal clock instead of a mechanical clock.

To understand the character of a thermal clock, let us look for a moment at the character of a mechanical clock. Here some specified body moves over a dial on which equal spaces are marked out, and equal times are those in which equal numbers of spaces are covered by the moving body. The fundamental clock is that in which the 'specified body' is a beam of light (this, of course, is only another way of expressing the familiar 'postulate of the constancy of the velocity of light' familiar to students of the theory of relativity), and clocks for practical purposes are constructed so as to give the same scale more conveniently. The time-scale suitable for the description of motion is thus one in which equal times are defined in terms of equal spaces, conformably with the measurement of motion by velocity defined as the rate of change of space with time. Similarly, the time-scale suitable for the description of radiation is one in which equal times are defined in terms of equal amounts of η, conformably with the measurement of radiation by temperature defined as the rate of change of η with time. Instead of the strictly specified body (a 'hand') moving over a space-scale (a 'dial'), we have a strictly specified body radiating to an η-measuring instrument, and equal times are those in which equal quantities of η are recorded by the instrument. We have to wind up the mechanical clock to keep its specified body moving continuously, and similarly we have, of course, to supply heat to keep the specified radiating body radiating continuously. In other respects also the two procedures are perfectly analogous.

In this way we provide a set of concepts, or terms of expression, for the description of radiation, which are intrinsic to the subject itself and not imported into it from without. The result is that just as mechanics has turned to advantage its choice of time measurement in terms of space by forming a unified conception of space-time, so the study of radiation along the lines suggested can turn to advantage its choice of time measurement in terms of η by forming a unified conception of η-time. To see the analogy, let us recall that in the ordinary theory of relativity the 'interval' between two events in the history of a moving particle is made up by combining a space increment with a time increment, and the relative magnitudes of these two components vary with the velocity of the co-ordinate system—that is, the velocity of the measuring instruments. When the co-ordinate system moves with the body, the interval consists entirely of the time increment, but for other velocities it is partly a time increment and partly a space increment. A similar thing is true of radiation. If we examine the radiation of a body with an η-measuring instrument and a thermal clock at the same temperature as the body, the former instrument records nothing and the thermal interval is wholly thermal time ; but if we use instruments at a temperature different from that of the radiating body, they both give finite records, and the transformation equations connecting the readings at one temperature with those at another (the thermal 'Lorentz equations') are such that a total thermal interval exists which is the same for all temperatures of the instruments.

The concept of η-time thus arrived at can be given a geometrical interpretation corresponding to that given to space-time by Minkowski. The null geodesic in space-time corresponds to motion with a velocity of $\pm c$, and that for η-time corresponds to radiation at a temperature of the absolute zero or infinity. There is the difference, however, that whereas space-time is 4-dimensional since space has three dimensions, η-time is 2-dimensional ; but, on the other hand, while the co-ordinate expression for the space-time interval is quadratic, that for the η-time interval is quartic. The geometries applicable to the two cases are thus different, and I have so far not been able to proceed beyond what I may call the 'special' theory, in which only constant temperatures are considered, just as in the special theory of mechanical relativity only constant velocities are considered. Constant velocities are appropriate to motions in a world of zero masses, and, similarly, constant temperatures are appropriate to radiation by bodies of infinite heat capacity. There is throughout a close parallelism between the new thermal and the current mechanical terms of expression, and we have an earnest of the possibility of ultimate amalgamation into a much more natural thermodynamics than the existing science of that name in the fact that thermal and mechanical time, though quite differently defined, give identical scales, and at any fixed temperature and velocity could be given the same unit. This is a necessary consequence, of course, of the experimental fact that a body at constant temperature radiates at a uniform rate according to our ordinary mechanical clocks.

The special theory of thermal relativity describes the same facts of experience as the current theory of radiation, but uses fundamentally different concepts for the purpose. So far as I can see, it entails nothing new in the field of observation, and in this respect it differs from the special theory of mechanical relativity which, when it superseded the earlier ideas based on absolute space and time, led to such discoveries as the dependence of mass on velocity, the equivalence of mass and energy, and other important relations. There are, however, two reasons for this. In the first place, pre-relativity mechanics was almost entirely concerned with velocities far from that of light, and the new requirements of the relativity theory thus related to conditions of which no experience had been obtained. The current absolute theory of radiation, however, is based on a relatively much wider range of experience, including that of phenomena at temperatures approaching the absolute zero. It has accordingly already adapted itself to the regions where anomalous results would be expected, so that the new theory is robbed of its chance of springing a surprise. Secondly, the general field of validity of the special theory of mechanical relativity —namely, the region of phenomena which can be discussed without considering the accelerating effects of gravitation—is a very large one, giving scope for many applications of the new principles. The special theory of thermal relativity, however, has scarcely any scope, for in all ordinary phenomena the effect of radiation is to lower the temperature of the radiating body very rapidly, and so to give variations of the radiation, the neglect of which is out of the question. Only bodies of very large heat capacity, like stars, come within its power, and we cannot make experiments with stars. New discoveries would therefore be expected to await the formulation of the general theory. But for our present purpose that is of little moment, for we are concerned more with the character and terms of expression of the laws than with the facts they represent, and these are as well exhibited in the special as in the general theory.

Whatever, then, may be the value of a thermal relativity theory from the heuristic point of view, it does, I think, show conclusively that it is possible to express the facts of radiation in terms totally different from the traditional ones, and so to preserve in our laws of motion and temperature the similarity of character inherent in the bare experiences. Each set of phenomena employs only concepts peculiar to itself—in mechanics, space and 'mechanical' time, and in temperature, η and 'thermal' time—and the measurements of the associated quantities are carried out by independent instruments. The connecting link is time, which, whether measured by the space covered by a moving body or by the η received from a radiating body, gives the same scale in the ideal cases of 'constant' velocity and 'constant' temperature. We can thus confirm the location of the rift in current physical theory in the arbitrary terms of expression chosen for our laws, leaving bare experience, if not necessarily quite homogeneous, at least sufficiently so to encourage the hope that a single scheme of law for all phenomena is a possible objective.

The One-Way Evolution of the Universe

Let us, in conclusion, look at the problem of the infinitely distant past and future from the point of view we have reached. We can say, first of all, that in so far as the problem arises from an extrapolation of existing laws, it is not a fundamental one. We can change the laws without violating experience. If they lead us into difficulties it may be necessary to do so, and if they lead us into contradictions or impossible situations we *must* do so. The fundamental difficulties are those which result from the trend of bare experience itself. If that leads us to an impossible situation, we must either fall back on the almost desperate expedient of trying to correlate our experiences without arranging them in a time order at all, or else capitulate and say that the universe is essentially irrational or (perhaps the same thing) beyond comprehension by human reason. I do not think, however, that we are yet reduced to that extremity.

In both its motion and temperature aspects the universe at present appears to be taking a one-way course. Its motions show a process of local consolidation and large-scale diffusion. This offers no problem for the future, for the diffusion can continue indefinitely and the consolidation tend asymptotically towards an eternally steady state. Working backwards to the past, however, we come by way of a large-scale consolidation and local diffusion to the idea of a single homogeneous mass, and, according to our present time-scale, this state would be located at a not infinitely remote epoch. The present discrepancy between the dates of this epoch yielded by the local and large-scale processes is a characteristic of our theories which can be ignored in our present considerations. What happened before this ? There is nothing that I can see to prevent that state having been reached by a gradual condensation of an originally infinitely diffused mass the rate of contraction of which, infinitely slow at first, accelerated until it culminated in a state of maximum density. After this a large-scale expansion could have proceeded, begun either by a rebound of a continuous mass from a state of compression, or by separate bodies simply continuing on their one-way journey after having made their closest approach to one another. Such a course of cosmic history would involve no problem of the distant past or distant future so far as motions are concerned.

What about temperatures ? The present trend is somewhat ambiguous. Our experience is so brief that we can detect no change in the temperatures of the stars, and any theories we may have on the matter are based on laws which we are now leaving out of account. Certainly there is a tendency towards equalization of temperature, shown by the fact of radiation from hot to cold bodies, but the probability is, nevertheless, that as we go backwards to remote times, the hottest bodies, the stars, become colder rather than hotter. I think it is in accord with present indications, so far as we can read them, to say that when we reach the time of maximum density of the universe, the stars, if they then existed, were cooler than now, and the temperature of the whole universe was more homogeneous. The tendency to local consolidation since that time has raised temperatures locally, and the large-scale expansion has checked the process of equalization. As we recede further into the past we contemplate a homogeneous mass of matter falling gradually in temperature step by step with its decrease in density, and there is no greater difficulty here than there is with the succession of motions. In the reverse direction, as we go from the present time towards the future, we presumably find the stars getting hotter up to a maximum temperature and then cooling, while all the time the

tendency towards equalization of temperatures by radiation goes on inexorably until ultimately the universe approaches asymptotically a state of uniform temperature.

We may sum up this picture of cosmic history, then, as follows. In the infinitely distant past the universe consisted of an infinitely diffuse, homogeneous mass at uniform temperature. With the passage of time the mass became denser and hotter until a state of maximum density was reached, and perhaps about this time the mass broke up into units. Thereafter a process of expansion went on, with the units getting hotter at varying rates but tending by radiation to come to a state of common temperature again. Ultimately they will reach and pass a maximum temperature, tending finally to a universe consisting of a number of aggregations of units at a common temperature performing eternally unchanging motions.

It should not be necessary to say that this is not intended to be in the slightest degree a theory of cosmogony. My purpose has been simply to give a conceivable course of development not inconsistent with the present trend of our experience, and involving no contradictions or insuperable difficulties in the distant past or the distant future. There may be a thousand such possible courses, and I am not concerned with the task of choosing between them. What I have tried to show is that not only does our present dilemma concerning the origin of things arise from our arbitrary laws, but also no such dilemma exists in the requirements of experience itself. The practice of 'induction of principles from phenomena', the origination of which Halley saw and did so much to facilitate, is still an endeavour worthy of our utmost effort.

[4] In course of publication.

TRANSFORMATION OF PNEUMOCOCCAL TYPES

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GRIFFITH[1] was the first to show that an attenuated and non-encapsulated 'rough' (*R*) variant of one specific type of Pneumococcus could be transformed into a virulent and encapsulated 'smooth' (*S*) form of another specific type. The transformation was accomplished *in vivo* by injecting subcutaneously a small amount of living *R* culture of Pneumococcus Type II together with a relatively large inoculum of heat-killed organisms derived from a fully virulent *S* strain of Pneumococcus Type I or III. The living *R* strain alone failed to kill mice, whereas the addition of the heat-killed Type I or III organism caused a fatal bacteriæmia. The organism isolated from the heart's blood of the infected animals, however, was not a virulent Type II organism, but a virulent encapsulated Type I or III pneumococcus according to the type of the heat-killed *S* vaccine employed. The importance of this observation was soon recognized, and Griffith's findings were confirmed by Neufeld and Levinthal[2], Baurhenn[3] and Dawson[4]. Some time later, Dawson and Sia[5] succeeded in carrying out the transformation of *R* Type II pneumococci into a virulent *S* Type III organism by an *in tivro* procedure.

In order to bring about this change, it is essential that the *R* variant should be in a reactive phase, since it is only when in this condition that an *R* culture is found to respond to the transforming stimulus. Once the organisms have assumed the type-specific *S* characters, they remain true to form through serial transfers in ordinary media and through repeated animal passage. In this work the greatest care was taken that the *S* vaccines employed contained no viable organisms.

The earlier work of Dawson and Avery[6] and Dawson[4] showed that the conversion of *R* pneumococci to the *S* form of the same type could frequently be accomplished by growing the organism in anti-*R* serum. In effecting this transformation of type *in vitro*, anti-*R* serum is generally added to the culture medium, although it is recorded that the transformation can frequently be achieved in the absence of *R* antibodies. It is now known that to obtain repeatable results, sulphonamide inhibitors must be removed from the nutrient broth used as culture medium. The transformation has never been observed to occur in the absence of serum, and failure to induce the conversion of resting cells seems to indicate that transformation takes place only during the active reproduction of the cells. Attempts to use solutions of the *S* organisms, obtained by freezing and thawing and afterwards heating at 60°, in place of whole bacteria, were mostly without success. Alloway[7], using extracts of virulent Types I and III pneumococci, was successful in effecting the transformation of an *R* Type II culture into fully virulent Type I and III organisms respectively. The conversion of *R* Type II into *S* Type I was more difficult and usually required several sub-cultures before the conversion was finally established. Alloway showed that serum from the sheep, rabbit, guinea pig, horse or man could be employed irrespective of its content of anti-*R* immune-body, thus indicating that some property in serum other than the anti-*R* component is essential if transformation of type is to occur. The presence of the specific polysaccharide of a heterologous type failed to induce the conversion of *R* Type II organisms into the heterologous *S* form.

The transformation of *R* pneumococci into a virulent *S* form means that the organism has acquired the property of producing the specific capsular substance, which for the Type III pneumococcus has been shown to be a polysaccharide built up from 4-β-glucuronosidoglucose units[8]. It would appear, therefore, that in the presence of a specific factor contained in an extract of the *S* Type III organism, the *R* Type II pneumococcus develops the capacity to elaborate the Type III specific material. In a later paper, Alloway[7] showed that potent extracts, as active as the original *S* vaccine in causing the $R \rightarrow S$ transformation, were obtained by dissolving the *S* cells in sodium desoxycholate, and that the active factor could be freed from certain of the accompanying impurities by precipitation with alcohol, or by adsorption of the contaminating substances on charcoal.

After a lapse of rather more than ten years, progress on this subject has once again been brought to notice by the publication of a paper by Avery, MacLeod and McCarty[9] which describes the isolation and identification of the active transforming principle present in an extract of *S* pneumococci (Type III). The evidence of its nature is based on an examination by chemical, enzymatic and serological analysis, and by electrophoresis, ultracentrifugation and ultraviolet spectroscopy. Within the limits of the methods

employed, the active factor is shown to contain no protein, unbound lipid or serologically active polysaccharide. The material contains 34–35 per cent C, 3·7–3·8 per cent H, 14–15 per cent N and 8·5–9·0 per cent P, and these figures are in close agreement with those calculated on the basis of the theoretical structure of sodium desoxyribonucleate (tetranucleotide). It is probably no mere coincidence that it is this type of nucleic acid which is found as a constituent of nuclei and chromosomes and, as shown by Signer, Caspersson and Hammersten[10] and by Astbury and Bell[11], is the form of nucleic acid that can exist in a highly polymerized and reactive state.

Bacteria that give a positive Feulgen reaction[12], that is, bacteria that have the property of restoring the colour of a fuchsine solution decolorized by sulphurous acid, are generally considered to contain a nucleic acid of the desoxyribose type. Thompson and Dubos[13] found that after the removal of ribonucleic acid from pneumococci, the resulting Gram-negative organisms give a strong colour reaction with Feulgen's reagent. These workers were, however, unable to isolate desoxyribonucleic acid from pneumococci, whereas Schaffer, Folkoff and Bayne-Jones[14] working with *Escherichia coli* and Johnson and Brown[15] with tubercle bacilli obtained nucleic acids from these organisms that appeared to be essentially of the desoxyribose type. Avery, MacLeod and McCarty are the first workers to isolate a desoxyribonucleic acid from Type III pneumococci and to accomplish an *in vitro* transformation of *R* Type II pneumococci into the *S* form of the heterologous Type III organism by means of this substance.

It is of considerable significance that an *R* bacterial cell in the presence of a desoxyribonucleic acid is stimulated to produce the specific capsular polysaccharide characteristic of the heterologous pneumococcus from which the nucleic acid molecule was itself derived. Although the transformation described by these workers is limited to a single type of change, it seems probable from the observations of earlier investigators that the process is one of general application. If a similar type of substance derived from other *S* cultures is found to bring about *in vitro* transformations of this kind, then it will appear probable that the desoxyribonucleic acids possess different biological specificities, as distinct from serological specificity, and that these can be recognized according to the nature and specific character of the capsular polysaccharide formed. Up to the present, little is known concerning the immunological specificity of the nucleic acids. Recently, Lackman, Mudd, Sevag, Smolens and Wiener[16] have shown that both *d*-ribo- and *d*-2-desoxyribo-types of nucleic acid react irregularly and with considerable serological overlapping when examined with anti-pneumococcal serum. The specific reactivity of certain anti-pneumococcal sera for nucleic acids can be specifically inhibited not only by the purines present in the nucleic acid but also by the methyl-purines, caffeine and theophyllin. Precipitins of similar reactivity do not occur in normal sera, so that it would appear that the anti-nucleic acid component of the serum has been formed during immunization with the pneumococci. It may be, however, that significant changes are induced[17] in the highly polymerized and complex nucleic acid molecules during the isolation and purification procedures generally employed, and that little progress will be made in establishing a relationship between chemical constitution and immunological specificity in this group of substances until they can be recovered in the native condition from tissues and bacterial cells.

It appears probable from the work of Avery and his co-workers that there exists within all types of pneumococci an enzyme which passes into solution during autolysis and rapidly destroys the activity of the transforming agent. To obtain optimal conditions for the conversion it is essential, therefore, to employ young cultures during the logarithmic phase of growth, since under these conditions cell division is most active and autolysis minimal. Although there is as yet no definite evidence as to the exact nature of the biochemical processes that operate during the transformation, it seems certain that a co-ordinated series of enzymatic reactions results which finally leads to the formation of the specific capsular polysaccharide and of the transforming agent itself. Once initiated, the process of forming these newly acquired characters continues through innumerable transfers of the organism without the addition of further transforming agent. Avery, MacLeod and McCarty point out that the experimentally induced alterations are definitely correlated with the development of a new morphological structure—the capsular polysaccharide—and the consequent acquisition of new antigenic and invasive properties. The changes are predictable, type-specific and heritable, and indeed the inducing substance has already been considered to be gene-like and the capsular substance to be a gene product. If one assumes that the desoxyribonucleic acid and the transforming agent are one and the same substance—as the experimental evidence strongly indicates—then the transformation of *R* Type II pneumococci into *S* Type III pneumococci represents a change which is chemically induced and specifically directed by a known chemical substance.

The genetic implications of this work are considerable, for it would appear that the transformation is a gene mutation and that the $R \rightarrow S$ change induced is, in fact, an authentic example of the accomplishment of a controlled mutation by a specific chemical agent. Examples of similar changes with other biological material, such as the conversion of the virus of rabbit fibroma (Shope) into that of infectious myxoma (Sanarelli) by Berry and Dedrick[18] and Berry[19] have already been given, and many more will certainly be forthcoming. This type of research is fundamental in character and of outstanding importance.

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INVASION OF THE NEW WORLD BY *ANOPHELES GAMBIÆ*

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"ANOPHELES GAMBIÆ in Brazil" is the title of a recent book[1] by Fred L. Soper and D. Bruce Wilson, in which is related the story of the recent incursion, and defeat, of the African mosquito, *Anopheles gambiæ* Giles, into South America. The importance of this book is that it is the record of man's first whole-hearted deliberate attempt completely to eliminate a small insect vector of disease from a geographically large area.

Previous campaigns against insects have usually attempted the elimination of the species from an area of limited size, or the aim has been merely to 'control' the species. 'Control' implies keeping the population of the species down to a level at which the depredations of crop pests cease to be economically important, epidemics due to insect-borne disease cease, a pandemic is driven back into small endemic centres, or the incidence of the disease reduced to a figure that is considered satisfactory. Striking examples are the control of the coco-nut beetle (*Promecotheca reichei* Baly) in Fiji[2], the extermination of the Mediterranean fruit fly (*Ceratitis capitata* Wiedemann) in Florida, where it had gained a foothold[3], and the elimination of urban yellow fever in South American cities by the local eradication of the tiger mosquito (*Aedes* (*Stegomyia*) *ægypti* Linnæus)[4]. 'Control' has one great disadvantage over complete eradication of a species in that the control measures have to be continuous.

Anopheles gambiæ was a purely Old World mosquito widespread in the Ethiopian region. However, in March 1930, R. C. Shannon collected it at Natal, Rio Grande do Norte, Brazil[5]. It is thought that the fast surface-mail service established by the French between Dakar and Natal rather than aeroplanes was responsible for its introduction, since there had been only three Africa to Natal aeroplane arrivals before Shannon's discovery. The late Dr. Adolf Lutz, veteran entomologist of the Instituto Oswaldo Cruz, had surveyed the area around Natal in 1928 in connexion with proposed sites for a leper colony, and he had pointed out to the authorities the danger of mosquito importation from Africa consequent on the development of rapid trans-Atlantic transport[1,6].

Ecologically, the district around Natal was not particularly favourable to *A. gambiæ*, and, with luck, the mosquito might have failed to establish itself: the problem created by its arrival looked like being one of localized control, until the mosquito just died out. This being so, the Yellow Fever Service (a joint organization of the Brazilian Government and the International Health Division of the Rockefeller Foundation) undertook immediate measures against *A. gambiæ* around Natal. This optimistic attitude was, however, shattered when, in April 1931, severe epidemic malaria broke out in the surrounding districts. Malaria had been endemic in some of these districts, but the new epidemics were so bad that wholesale emigrations of the populace were taking place. These epidemics were due to the presence of *A. gambiæ*, acting as a vector; a year after being first discovered on South American soil, the mosquito had spread a distance of 182 km. from its first recorded foothold.

The locality of the initial infestation by *A. gambiæ* was a district where tidal flats had been transformed into 'freshwater hayfields' by the erection of dykes to exclude the tidal salt waters. *A. gambiæ* could have been eliminated at this stage by opening the dykes and admitting the salt water. This action was, in fact, recommended in May and September 1930, and again later, but it was only after the disastrous malaria epidemic of 1938 that it was done, the local health officers not having sufficient powers to overcome the opposition of the interests which stood to suffer loss by the opening of the dykes.

The localized work of the Yellow Fever Service cleaned up the situation around Natal, and the danger to the State capital having been removed the local authorities became disinterested in the matter though, fortunately, the workers of the Rockefeller Foundation continued to keep an eye on *A. gambiæ* in the outlying districts.

During 1932–37 *A. gambiæ* spread slowly, but little attention was paid to it until, in 1937, the mosquito was suspected of being responsible for localized epidemics of malaria, and in 1938 it was proved responsible for severe outbreaks of epidemic malaria in the coastal regions of Rio Grande do Norte, north of Natal and in the valley of the Jaguaribe River in the neighbouring State of Ceara. This epidemic wrought such havoc that tax-holidays had to be declared in certain localities and travelling representatives of business houses refused to enter the affected districts.

The State Governments appealed to the Federal Government, and in August 1938 the President of Brazil signed a decree creating the Anti-Malaria Service. This service was immediately organized under Dr. Manœl Ferreira, and a laboratory for research on *A. gambiæ*, as the species occurred in Brazil, was set up at Natal under Dr. Cesar Pinto of the Instituto Oswaldo Cruz[6]. The International Health Division of the Rockefeller Foundation, already actively co-operating with the Federal Government in the highly successful Yellow Fever Service, continued to keep an eye on the situation. In the course of preliminary discussions with the Brazilian Government it was concluded that if the spread of *A. gambiæ* was not stopped a major disaster threatened the Brazils, and no one could tell how many of the Americas would eventually be affected. It was therefore agreed that any programme of work should aim at the immediate eradication of the species.

In January 1939 arrangements were completed for collaboration between the Anti-Malaria Service of the Brazilian Government and the International Health Division of the Rockefeller Foundation in a new organization to be called the Malaria Service of the Northeast. This new body immediately set going a medical treatment campaign, commenced the systematic disinsectization of all vehicles, boats and aeroplanes proceeding from the infested region to clear areas, and made an immediate start on the actual attack on the mosquitoes themselves. At the peak of its activity the personnel employed exceeded 3,500, but the maximum number of medical men employed was forty-nine. During the period of its existence the Service used more than 6½ million tablets of atebrine and quinine. Some 11 million samples of water were examined for mosquito larvæ; more than 104 million collections of water were treated with anti-larval measures, 261,292 kgm. of Paris-green being used for this purpose; 720,906 litres of insecticide were used to disinfest houses,

vehicles, etc., of the adult mosquitoes. In 1940 alone 7,036,731 mosquito larvæ, of which 17,425 were *A. gambiæ*, and 972,248 adult mosquitoes, of which 56,780 were *A. gambiæ* were examined. The expenditure for for the whole period of the existence of the Malaria Service of the Northeast totalled 2,139,570.27 dollars.

The work of the first six months was not over-encouraging, but in the second six months localized eradications had been effected and the problem seemed to be resolving itself into one of administration. Early in April 1940, the vital experiment of stopping all control measures in an area that had previously harboured *A. gambiæ*, but which appeared to have been cleared of the mosquitoes, was made. *Anopheles gambiæ* did not reappear. The actual technique of destruction had proved simpler and more rapid than was at first anticipated, and faith in the ideal of complete and total eradication of the species began to grow by leaps and bounds. From this time anti-*gambiæ* work was stopped in any previously infested area after it had been found to be free from the mosquito for three months.

The clearance of areas allowed additional personnel to be concentrated on the less tractable districts, and this act was reflected in the rapidity with which the final stages of the elimination of *A. gambiæ* were accomplished. Less than two years from its inception, on November 14, 1940, the Malaria Service of the Northeast recorded the last evidence of infestation by *A. gambiæ* in Brazil, and in January 1941 all anti-*gambiæ* measures were suspended.

The evidence that *Anopheles gambiæ* has been eradicated from Brazil is all of a negative character, but Soper and Wilson[1] consider that it has, in fact, been effected. That reinfestation is possible has been shown by the recording by Soper and Wilson[1] of specimens of *A. gambiæ* found in aeroplanes arriving at Natal from Africa. In the future, vigilant disinsectization of aeroplanes must be insisted on.

The collaborative Malaria Service of the Northeast was brought to an end in the middle of 1942, having demonstrated that the goal of species eradication from a large area was attainable. Soper and Wilson[1] admit that there are features of the ecology of *A. gambiæ* which, related to the nature of the terrain invaded, favoured eradication. They also point out, however, that when species eradication is the goal aimed at, matters are simplified, compared with the institution of mere control measures, since the problem becomes a purely entomological one completely divorced from all medical and epidemiological considerations. The test of success is not the reduction of any selected index relating to the disease to some predetermined, or hoped-for, figure, but simply the complete and continued absence of the species attacked after the campaign has ended. The Malaria Service of the Northeast was fortunate in having available for incorporation the trained personnel of the Yellow Fever Service.

No amount of argument will prove that species eradication, as a method of dealing with malaria and other insect- or arthropod-borne diseases, is not applicable elsewhere. Only the failure of properly organized and adequately financed attempts will do so. The cost may be high, but against this must be set the ever-recurrent losses due to the diseases and the annual cost of such control measures as are in vogue. These measures may cost enormous sums of money in the long run, but it is notorious that men, when organized as a society, tend to prefer annual recurrent small expenditures even though they may be far less effective and be far larger in the aggregate than the cost of a short intensive campaign promising finality. Soper and Wilson[1,4] do not claim that the method of species eradication is applicable everywhere or to any vector. They point out that in the first place the presence of the vector must be creating a public health problem sufficiently grave to justify the expenditure of time and money involved and the interference with the life and rights of the community necessary for the efficient application of the anti-vector measures. Secondly, the vector must be one which can be attacked successfully; that is, it must be possible to seek out and discover the vector with comparative ease, and methods of killing it in its breeding places must be available. Thirdly, it must be possible to clean up an isolated area unlikely to be reinfested, or the area to be cleared of the vector must be sufficiently large so that the peripheral region, where measures will have to be persisted in to prevent reinfestation, will be small in comparison with the area cleared.

Soper and Wilson[1], discussing the problem of *A. gambiæ* in Africa, point out that there the eradication would have to be centrifugal, while the campaign in Brazil was a centripetal one; they also point out that the problem in Africa would be complicated by the presence of *Anopheles funestus* Giles, a very efficient malaria vector, alongside of *A. gambiæ*. They point to the isolated malaria-ridden valleys of Peru, where a single species, *Anopheles pseudopunctipennis* Theobald, is the vector[7], and the islands of the Caribbean, as localities where species eradication would seem particularly feasible.

Soper and Wilson[1,4] have stressed the desirability of tackling any case of species eradication as an immediate problem without any postponement of the attack on the species pending the completion of some elaborate programme of detailed research on that species. It is, however, perhaps pertinent to point out that a considerable amount of basic research had been carried out on *A. gambiæ* in its Old World home before it reached Brazil; the results of these researches were, of course, available to those responsible for the campaign against the species in Brazil. There is probably a judicious mean between the two policies, though individuals may tend to lean toward one or the other extreme.

It might be well worth while to consider the place that species eradication campaigns might have in relation to the Colonial improvement programmes that are being mooted at the present time. The personnel problem should not prove intractable, since it is likely that, on the cessation of hostilities, many members of the Forces who have been engaged on anti-malarial or other related entomological work will be returning to civil life and might welcome an opportunity to continue such work. Such personnel might well be used to form the core of species-eradication organizations, and staff for routine operations could be recruited from the local populations.

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NEWS and VIEWS

Agricultural Research Council: Secretaryship

IT is announced that Mr. J. C. F. Fryer, director of the Plant Pathological Laboratory of the Ministry of Agriculture at Harpenden, has been appointed to succeed the late Prof. W. W. C. Topley as secretary of the Agricultural Research Council. Mr. Fryer is well known in scientific and official circles and his appointment to this responsible position is amply justified by his special qualifications. He has held his present post for a number of years and at one time it was combined with that of entomologist to the Ministry of Agriculture. Much of the improved technique applied in recent years to pest control has been the result of work initiated or fostered by Mr. Fryer in his official capacity. Educated at Cambridge, and for some time fellow of Gonville and Caius College, Mr. Fryer became Balfour student of the University. During his tenure of this studentship he carried out important researches on the genetics of butterflies in Ceylon and also investigated the fauna and physiography of Aldabra Island in the Indian Ocean. His subsequent career began with the Board of Agriculture and coming from a family well versed in farming experience he brought to his duties practical experience backed by scientific knowledge. His long and close association with this branch of Government service has left him comparatively little opportunity for other activities. Nevertheless, his name is among those who have occupied the presidential chairs of the Royal Entomological Society and of the Association of Applied Biologists. In the appointment of Mr. J. C. F. Fryer, the Agricultural Research Council has placed its secretaryship in exceptionally capable hands.

Stereoscopic Projection

ON June 17, at the Aldis Works, Birmingham, Mr. A. C. W. Aldis gave a demonstration of the stereoscopic projection. He employed special high-intensity projectors of his own design which gave a vivid impression of stereoscopic relief when viewed through the usual coloured anaglyphs. These projectors gave a remarkable efficiency with brilliant screen illumination in spite of the loss of brightness involved by the use of anaglyphs and coloured filters for the screen projections.

Mr. Aldis's approach was through the theory of stereoscopic vision. He invited his audience by suitable screen tests to determine their own stereoscopic appreciation, and produced by means of plane geometrical patterns projected from 50 ft. or more an impression, when viewed through anaglyphs, of a suspended luminous sphere which appeared to move towards the observer, meanwhile diminishing in size. The latter part of the demonstration showed the modern method of prospecting for minerals in jungle territory by means of stereoscopic photographs of the terrain, and was followed by scenes from the actual bomb damage in Germany including the Möhne Dam before and after the attack, the Eder Dam, the Herdicke Bridge and the damage to Mainz, Rostock, Düsseldorf and the Phillips Radio Factory at Eindhoven. These photographs, when viewed by stereoscopic vision, were particularly convincing, and the wealth of detail exhibited gave adequate testimony to the value of the method of projection which Messrs. Aldis have devised.

Penicillin Treatment of War Wounds

THE Medical Research Council's War Memorandum No. 12, entitled "The Use of Penicillin in Treating War Wounds" (H.M. Stationery Office, 1944. *3d.* net), is a valuable publication embodying the instructions issued by the Penicillin Trials Committee of the Medical Research Council. There is a prospect, says the memorandum, that large quantities of penicillin may shortly be available and in particular it may be possible to treat a considerable number of casualties in forthcoming military operations. The memorandum is intended to be a guide for the treatment of battle casualties and for the laboratory control of such treatment, and it does not pretend to be a guide to all the clinical uses of penicillin (for a note on these see NATURE, April 29, p. 521; 1944). Further, its instructions are provisional, because experience of the treatment of wounds with penicillin is still relatively small. The properties of penicillin are briefly discussed, and a list is given of the bacteria which are susceptible and resistant to it. Other sections deal with the preparation of penicillin and with its local and systemic administration, with its uses for particular types of wounds, with failures of the treatment and with the laboratory procedures which are necessary for the control of the treatment (diagnosis of the bacteria present, titration of the penicillin content of the blood and of the potency of the penicillin). The memorandum concludes with a valuable list of selected publications and memoranda on penicillin.

Polish Medical Science

THE medical issue of "Polish Science and Learning" (London: Oxford University Press, 1944. *2s. 6d.*), which is one of a series of booklets edited by the Association of Polish University Professors and Lecturers in Great Britain, is, its editors state, an attempt to lay a foundation for the future in collaboration with the scientific workers of other nations. The creation of the Polish Medical School and of the Paderewski Hospital in Edinburgh is, as Prof. Jurasz says in his article about them, a symbolic act, a practical demonstration of the determination of the Polish people to continue their national life in spite of all the sufferings of their country; and it demonstrates the existence of practical collaboration between two very different nations. It is perhaps difficult for some Englishmen to realize what hope and encouragement the creation of these two medical centres has meant to the Polish people. Already fifty-three students have graduated from the Polish Medical School. Many civilian students who are unfit for the Polish armed forces have joined it after leaving their schools in Great Britain, and others have got leave from the Army to continue their studies interrupted by the War, while some have gone there from the U.S.S.R. or after their escape from German prison camps. The Paderewski Hospital is devoted entirely to Polish patients and to the training of medical students and graduates. In addition to this hospital provision, valuable work has been done by a Polish sanatorium for tuberculous cases in Great Britain. Established at the end of 1942 at Gallowhill Hall, this sanatorium has now a capacity of one hundred beds and can carry out the best treatment. The majority of Polish cases of tuberculosis are, however, still distributed throughout British hospitals and Polish military hospitals. The percentage of tuberculosis, says Dr. Spitzer, is higher now among

Poles in exile than it was in Poland before the War, so that there is urgent need of the developments which are contemplated.

Something of what is happening in Poland now may be imagined by reading between the lines of the extract from a secret report on the condition of the Polish children which this journal publishes. At all ages the theoretical rations of Polish children are half the theoretical normal calorie value, while those of Nazi children are well above this norm. In practice, the writer of this report states, the quantity and quality of the food fluctuate; sometimes it is reduced to nil. In the Rodom district, for example, the children of the landworkers do not get any ration cards at all. Almost everywhere the distribution of milk to children under three has been suspended. The writer concludes that the rations show a deficiency of 90 per cent of fats, 80 per cent of albumins and 50–60 per cent of carbohydrates. It is not surprising that infectious diseases and "a frightening mortality", with a high percentage of tuberculosis, which is increasing, and of heart weakness are evident among Polish children. These conditions are, as recent articles in the *British Medical Journal* and *The Lancet* and discussions in the Houses of Lords and Commons have shown, reproduced in most of the occupied countries. It is easy to exaggerate them; but we should not commit the graver error of underestimating their consequences. The agricultural basis of European rehabilitation is clearly recognized, and Polish veterinarians have for long been co-operating with British veterinarians in the reconstruction of Polish veterinary medicine. An article on this, and others on the improvement of Polish milk hygiene and on the eradication of tuberculosis from Polish cattle, 25–50 per cent of which are, Dr. Mglej tells us, tuberculous, indicate that this aspect of the future is not being neglected.

Classification in Biology

THE question is often asked by students as to which is the 'right' classification of a group of animals. Mr. K. H. Chapman, lecturer in zoology, Rhodes University College, Grahamstown, South Africa, directs attention to certain ideas that must be kept in mind when considering schemes of classification from this point of view in a communication to the Editors which is summarized below. Although such conceptions have been put forward before, there persists so much misconception about the nature and purpose of systematics in biology, not only among students but also among biologists themselves, that it is necessary to re-emphasize these points. It is probable that no classification is right or definitive because there is no real classificatory system outside ourselves that it is only necessary for us to discover. In most groups it is obvious that we can only deal with survivors; and even where fossils do exist, they are unselected members of the group from this point of view. Thus it follows that natural classification is an unfortunate term. Living animals do not fall into true and equivalent groups even though we arbitrarily place them in such, and consequently we can only regard classification as a convenient tool with which to deal with a large mass of material, and it does not have a natural existence of itself. It is only necessary to compare the species, genera and other groups of insects with the similarly named categories in other phyla to realize their non-equivalence. The species, whatever it may be, also must be regarded as a dynamic and not a static unit, and any living group may, in the course of time, become something different. The question of polyphylletic origins also arises; for example, W. A. Herdman suggested that the compound ascidians are an assemblage of groups evolved from different groups of the simple ascidians which had independently assumed the colonial habit of growth. Any classification is to be regarded as an expression of a scale of values which indicates, in the opinion of its proposer, the relative nearness or farness of two or more groups with respect to one another.

The British Bryological Society

FEW associations of naturalists have been originated by advertisement, but such was the genesis of the Moss Exchange Club. The Rev. C. H. Waddell first advertised in *Science Gossip* in December 1895 and, from the twenty-three favourable replies, founded the Club in the following year, when 2,077 specimens were distributed. It remained an association depending very largely on postal contact until 1922, when the need for closer personal association in field meetings led to the formation of the British Bryological Society. Miss Eleonora Armitage has collated the annual reports of both Club and Society into a short pamphlet (Miss Armitage, Dadnor, Ross). She was president at the Society's last meeting in 1939, and this review should serve the purpose of sustaining the collective interests of bryologists until more stable times allow a resumption of their activities. Several census lists of British bryophytes have been published, from the York Catalogue, compiled by J. A. Wheldon in 1889, to the latest taxonomic indexes for mosses, compiled by J. B. Duncan in 1926, and for hepatics, by A. Wilson in 1930. The taxonomy of mosses and liverworts is now largely established, but many bryological matters still require elucidation. Perhaps the post-war period will provide opportunities for detailed ecological studies —the relation of a moss or liverwort to its substrate, its reactions with other plants, and particularly of its unique physiology, which allows a special phenology of reproduction not possessed by any other kind of plant.

Work of the League of Nations

THE report on the work of the League of Nations during 1942–43, submitted by the Acting Secretary-General, in addition to an introductory section giving a useful survey of proposals for future world organization, contains chapters on economic, financial and transit questions, on questions of a social and humanitarian character, on questions of a legal and administrative character and on the Library of the League. The work of the League on the first group of questions is reflected chiefly in a series of reports which have already been noticed; but in regard to the second group, the report affords strong evidence that whatever views may be held as to the continuance of the League as a co-ordinating machinery in political affairs, its technical organizations should be retained as part of the functional apparatus set up in any future world organization.

The Health Section has concentrated its attention during the year on the present food scarcity, and on malnutrition and the danger of epidemic outbreaks in Europe. A comprehensive study of the trend of morbidity and mortality of European countries in relation to food shortage is shortly to

appear in the *Bulletin of the Health Organisation*. The Organisation has also been requested to determine which food elements are most acutely lacking in the present dietary of enemy-occupied countries, so that foods prepared by the Allied Food Relief Organization should, in the form of adequate complement rations, compensate present deficiencies. Information on the health situation in Europe was summarized in a series of notes on the prevalence, trend and probable course of typhus fever, cerebro-spinal meningitis, enteric fever, scarlet fever, smallpox, poliomyelitis, etc., and typhus fever was also the subject of a special study. The Singapore Bureau functioned until less than a week before the occupation of Singapore by the Japanese in January 1942. The activities of the Health Information Service have been maintained, and a study on the significance of names of communicable diseases in various languages was amplified and extended to form the basis of a comprehensive glossary in twenty-four languages of the communicable diseases. Research has continued on several subjects on the agenda of the Permanent Commission on Biological Standardization, including the nature of the toxins produced by the tetanus germ and by *Bacillus perfringens*, one of the agents of gas gangrene.

In regard to the Control of the Drug Traffic, international supervision has been impaired by the deterioration of communications, and difficulties in obtaining the necessary supplies have in some South American countries led to plans to produce raw opium and to manufacture drugs. The report directs attention to the danger that an excess of manufacture over legitimate needs may follow, and to the importance of taking, as soon as possible, all necessary steps to restore the full measures of control as they existed before the War. Work has already commenced on a post-war planning programme in this field, which includes a study and review of present national and international systems of control, with the view of suggesting improvements, and a study has been made of the legal position of drug addicts and current methods for treatment of addiction. The collections of the Library comprised about 318,200 volumes at the end of 1942, and in view of the exceptional facilities for work which the documentary material available will offer after the War, the secretariat is studying the means by which a gradual return to normal conditions may be effected.

Smithsonian Institution : Annual Report

THE report of the Secretary of the Smithsonian Institution for the year ending June 30, 1943, includes the report of the secretary and the financial report of the executive committee of the Board of Regents, together with the usual reports of the United States National Museum, the National Gallery of Art, the National Collection of Fine Art, the Freer Gallery of Art, the Bureau of American Ethnology, the International Exchange Service, the Astrophysical Observatory and on the Library. The secretary's report points out that all personnel and facilities of the Institution and its branches were made available and extensively used in the prosecution of the War, although the normal activities were kept alive to the extent of continuing observations the cessation of which would leave permanent gaps in records essential for future investigations and of maintaining and caring for the national collections. All other research and exploratory projects not required for the orderly resumption of cultural activities after the War have been suspended, except those activities relating to closer cultural co-operation with the other American republics. Much of the Institution's contribution to the war effort is of an indirect nature. More than a thousand recorded inquiries had been answered up to the close of the fiscal year, and a list of selected examples tabulated by the War Committee shows not only the wide range of these questions but also the extent to which modern total war depends on scientific knowledge.

War research projects have also been concerned with many different branches of science, including anthropology, biology, geology, physics and meteorology, and these projects occupied almost the whole time of the instrument and mechanical shops of the Astrophysical Observatory, the Division of Radiation and Organisms and the Division of Engineering, as well as of numerous individual members of the scientific staff. With regard to inter-American co-operation, the report refers to the organization of an Inter-American Society of Geography and Anthropology, with membership open to scientific workers anywhere in the hemisphere. More than 700 members have already been enrolled. The first part of a check list of the coleopterous insects of Mexico, Central America, the West Indies and South America is now in the Press as a bulletin of the National Museum. A prediction of the march of solar variation during 1939–45 based on periodicities revealed by the solar-constant values published in vol. 6 of the *Annals of the Astrophysical Observatory* shows that the years 1940–47 will be the most important years to study the sun's variations since the early twenties, and for this reason every effort has been made to keep the three field observatories in Chile, California and New Mexico in operation. With regard to the international exchanges, the report records that the Office of Censorship lifted in January 1943 the ban imposed in April 1942 on sending abroad the *Congressional Record* and the *Federal Register*.

Office Organization in Engineering Works

A BOOKLET issued by the British Standards Institution, "Office Organisation and Practice" (B.S.1100; Part 10; 1943), states in some detail the underlying principles of good office management and clerical organization, and gives practical guidance as to the installation of a system and the technique of office and clerical organization. It is addressed primarily to engineering firms of 250–1,000 employees with offices of 20–100 clerks, but the large amount of basic information on office practice condensed and set out simply in this booklet should be equally valuable to smaller firms in all branches of industry. Sections are included on the planning of systems ; the design and use of forms ; the use and selection of machines and other devices, with an appendix listing suppliers ; accommodation, lay-out, lighting and heating requirements of offices ; personnel organization, including the grading of jobs and standards of performance and incentives ; training, selection, co-ordination and control of staff, and methods of inspection of work. Typing is dealt with in a separate section including both selection and training and the pool system, while a further section deals with communications, both inward and outward mail, the use of telephones and messengers. There is a short

section on filing and another on sales invoicing. A short bibliography and an index add to the value of the publication.

Institution of Electrical Engineers : Annual Report

ACCORDING to the report for the year 1943–44 of the Council of the Institution of Electrical Engineers, total membership on March 31, 1944, numbered 24,558, and of those there were 11,924 corporate members; 2,944 elections to all classes of membership were made during the previous twelve months. During the year 562 meetings were held in London and at the local centres. The Wireless Section held fifteen meetings, the Measurements Section eight, the Transmission Section eight, the Installations Section seven, and there were six informal meetings. There are nine students sections. Post-war planning has received close attention at the hands of the committee appointed for the purpose, and reports have been published on "Education and Training for Engineers", the "Organization of Post-War Electrical Research", and on "Electricity Supply, Distribution and Installation." A report on "Electricity in Post-War Building" has been completed by the Electrical Installations Committee and is being published by H.M. Stationery Office. The Council's report also deals with various phases of the Institution's war effort, with technical investigations, joint activities with other institutions, and with the subject of education. The revised eleventh edition of the Regulations for the Electrical Equipment of Buildings has been issued during the year.

Monthly Astronomical Newsletter

BART J. BOK, Harvard Observatory, prepares a *Newsletter* each month for the American Astronomical Society which is intended to keep scientific societies informed about progress in various branches of astronomy during the disruption of exchange of information. Some of the notes are duplicated in other publications, such as *Sky and Telescope*, and by Science Service. The present issue, No. 17, contains brief references to papers and notices in *Harvard Announcement Cards*, the *Astrophysical Journal*, *Popular Astronomy*, etc. A considerable portion is devoted to a review of contributions by Dr. N. T. Bobrovnikoff and others on the physical properties of comets.

The Night Sky in July

FULL moon occurs on July 6d. 04h. 27m. U.T., and new moon on July 20d. 05h. 42m. The following conjunctions with the moon take place: July 18d. 08h., Saturn 1° N.; July 22d. 01h., Mercury 0·7° S.; July 22d. 20h., Jupiter 2° S.; July 23d. 11h., Mars 2° S. The following conjunctions in addition to the above also take place: July 5d. 08h., Mars in conjunction with Jupiter, Mars 0·2° N.; July 10d. 04h., Mars in conjunction with Regulus, Mars 0·7° N.; July 20d. 12h., Jupiter in conjunction with Regulus, Jupiter 0·5° N.; July 28d. 08h., Mercury in conjunction with Regulus, Mercury 0·01° N.; July 29d. 17h., Mercury in conjunction with Jupiter, Mercury 0·7° S. Occultations of stars brighter than magnitude 6 are as follows: July 2d. 21h. 20·9m., θ Libr (D); July 30d. 21h. 57·7m., χ Ophi. (D). The times refer to the latitude of Greenwich and (D) means disappearance. Mercury is in inferior conjunction on July 1. At the middle of the month the planet sets 50m. after the sun and at almost the same interval at the end of July. Venus is too close to the sun to be conveniently observed until late in the month. On July 31 the planet sets less than half an hour after the sun. Mars, in the constellation of Leo, can still be observed as it sets 2h. after the sun at the beginning of July and 1h. 10m. after sunset on July 31. Jupiter, in the constellation of Leo, is drawing near the sun, setting only 50m. after sunset at the end of July. Saturn is no longer visible. The earth reaches aphelion on July 3 when its distance from the sun is 94,560,000 miles. An annular eclipse of the sun, invisible at Greenwich, takes place on July 20. At Bombay the magnitude of the eclipse is 0·95, at Hong Kong 0·90, and at Madras 0·80.

Announcements

THE following elections to the Royal Society have been made: fellow of the Royal Society under Statute 12: the Right Hon. S. M. Bruce, High Commissioner for Australia in London. Foreign members: Dr. O. T. Avery, bacteriologist, member of the Rockefeller Institute, New York; Prof. M. Lugeon, professor of general geology and stratigraphy in the University of Lausanne; Prof. The Svedberg, professor of physical chemistry in the University of Uppsala; Prof. N. E. Svedelius, professor of botany in the University of Uppsala; Prof. S. Timoshenko, professor of engineering mechanics in the University of Michigan.

THE director of the Chinese National Central Library has offered to provide British scholars with Chinese material for specialist researches, and to arrange for its translation into English if this is desired. The Library will also forward lists of books available to interested institutions in Great Britain. The British Council has undertaken to act as intermediary on the British side; all inquiries should be addressed to the Director, Books Department, British Council, 3 Hanover Street, London, W.1.

Two prizes of 200 dollars each, offered by Mr. A. Cressy Morrison, to be known as the A. Cressy Morrison Prizes in Natural Science, will be awarded in December 1944 by the New York Academy of Sciences. Papers, which must embody the results of original research not previously published, must be submitted on or before October 1, 1944, to the Executive Secretary of the New York Academy of Sciences, at the American Museum of Natural History, Central Park West at 79th Street, New York, N.Y.

THE University of Birmingham is to award Anglo-American studentships to encourage research in some branch of petroleum technology. These studentships will normally be awarded for one year, but may be renewed for a second year, the value of the award being £225 for the first year and £250 for the second year, if renewed. They are open to graduates of the University of Birmingham and science graduates of other universities. Applications, which should include a statement of age, academic qualifications and career, should be submitted to the Registrar of the University of Birmingham by July 15. Applicants must also submit the names of two referees.

ERRATUM. In the communication "Thermal Fatigue in Metals" by W. Boas and R. W. K. Honeycombe printed in NATURE of April 22, p. 494, the illustration has been inverted: photomicrograph d should be a; c should be b; b should be c; and a should be d.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

New Components of the Vitamin B Complex

AN attempt to prepare a concentrate of folic acid from liver by the method of Hutchings *et al.*[1] resulted, as already noted in a recent review[2], in the preparation of a fraction probably containing folic acid, together with another fraction soluble in chloroform, which likewise stimulated the growth of certain micro-organisms. A second chloroform-soluble fraction with similar properties has now been obtained. All three of these fractions stimulate the growth of *Lactobacillus helveticus* and *Streptococcus lactis* R 8082, but not that of *Lactobacillus arabinosus* 17/5. Although the growth-promoting properties of the chloroform-insoluble fraction are probably due to folic acid, the chloroform-soluble fractions are believed to contain new factors not previously described.

At first, an alcohol precipitate obtained as a by-product in the manufacture of commercial liver extracts was used as the starting material for the preparation of these fractions; but later, it was found more convenient to prepare the chloroform-soluble factors from the liver extract ('Examen') itself, manufactured according to the method of Laland and Klem[3]. This was subjected to the following fractionation procedure: extraction with chloroform at *p*H 3, concentration of the washed extract *in vacuo* to dryness; solution of the residue in water; adsorption on 'Decalso' at *p*H 4·5; elution with hot 10 per cent sodium chloride solution; extraction of the eluate with phenol at *p*H 3; and transference of the activity to water by addition of ether.

The eluate and the combined 'Decalso' filtrate and washings were each concentrated *in vacuo* to the original volume of the 'Examen'. In this way, two fractions were separated, an eluate and a filtrate factor.

Both concentrates stimulated the growth of *L. helveticus* and *S. lactis* R when added in place of a folic acid concentrate, but in different ways. With *L. helveticus*, the presence of both factors produced a synergistic effect, whereas with *S. lactis* R, the effect was additive. The concentrates were added at levels of 0·5, 1·0 and 2·0 and occasionally at 4 ml./10 ml. to a basal medium which was a modification of the basal medium described by Landy and Dicken[4]. At levels of 2–4 ml./10 ml. of medium, the filtrate factor alone appeared to be a complete substitute for folic acid for both organisms, but a mixture of the filtrate and eluate factors could replace folic acid at much lower levels (0·1–0·5 ml./10 ml. of medium). In the case of *S. lactis* R the effect appeared to be purely additive, but with *L. helveticus* the effect was greater than the sum of the growth-stimulating effect of each. Two typical results are given below, expressed as the amount of standard alkali necessary to neutralize the acid produced:

L. helveticus. Incubation for 48 hr. at 37°.

Chloroform-soluble filtrate factor

ml. concentrate in 10 ml. medium	Blank	0·5	1·0	2·0
ml. 0·1 *N* NaOH	0·1	2·1	4·5	6·8

Chloroform-soluble eluate factor

ml. concentrate in 10 ml. medium	Blank	0·5	1 0	2·0
ml. 0·1 *N* NaOH	0·1	0·9	0·9	0·9

Chloroform-soluble filtrate + eluate factors

ml. concentrates in 10 ml. medium	Blank	0·1 + 0·1	0·5 + 0·5	1·0 + 1·0	2·0 + 2·0
ml. 0·1 *N* NaOH	0·1	2·6	4·5	8·3	9·9

The synergistic effect of the two factors together is clear from these results.

S. lactis R incubated for 72 hr. at 30°.

Chloroform-soluble filtrate factor

ml. concentrate in 10 ml. medium	Blank	0·5	1·0	2·0
ml. 0·05 *N* NaOH	0·1	2·0	2·8	5·4

Chloroform-soluble eluate factor

ml. concentrate in 10 ml. medium	Blank	0·5	1·0	2·0
ml. 0·05 *N* NaOH	0·1	1·4	1·9	2·7

Chloroform-soluble filtrate + eluate factors

ml. concentrates in 10 ml. medium	Blank	0·1 + 0·1	0·5 + 0·5	1·0 + 1·0	2·0 + 2·0
ml. 0·05 *N* NaOH	0·1	2·1	3·2	6·3	8·2

Here the influence of the two factors is apparently additive.

Neither of the chloroform-soluble factors was destroyed by nitrous acid, by acetylation with acetic anhydride in sodium hydroxide solution (at room temperature), or by benzoylation with benzoyl chloride and sodium hydroxide solution.

The chloroform-soluble factors appear to be different from folic acid and indeed from other similar factors described in the literature, which are all reported to be insoluble in the common organic solvents, except glacial acetic acid.

The full experimental evidence will be published in due course.

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June 13.

[1] *J. Biol. Chem.*, **141**, 521 (1941).
[2] NATURE, **153**, 478 (1944).
[3] *Acta Med. Scand.*, **88**, 620 (1936).
[4] *J. Lab. Clin. Med.*, **27**, 1086 (1942).

An 'Incomplete' Antibody in Human Serum

A STUDY of the properties of mixtures of different types of human anti-*Rh* sera has led to the recognition of what appears to be an incomplete antibody. The research arose out of a suggestion by Prof. R. A. Fisher that this technique might throw some light on the problem of antibody absorption.

Human anti-*Rh* serum of the type called by Wiener "standard" agglutinates red cells of the gene Rh_1 and also those of Rh_2. 'Anti-Rh_1' serum agglutinates the former cells but not the latter[1,2]. If, however —and this was the observation that started the present work—cells of the genotype Rh_2Rh_2 or Rh_2rh are added to a mixture of these two sera, the expected agglutination due to the standard anti-*Rh* serum does not occur. It was then found that the sera need not be mixed, for if the Rh_2 cells are suspended in anti-Rh_1 serum—which causes no agglutination—and after a few minutes are separated from the serum, washed and re-suspended in saline, then these treated cells can no longer be agglutinated by standard anti-*Rh* serum.

In January of this year Fisher drew up the following formulation of the relationships found in the Rhesus factor, designed to distinguish the three categories, antigens, genes or allelomorphs and antibodies for which provision must be made in a satisfactory notation.

Name of serum:		Anti-*Rh*$_1$	*St*	Anti-*Rh* Standard	Anti-*Rh*$_2$	Not yet found	
Antibody present:		Γ	γ	Δ	H	δ	η
Genes							
Rhz	*CDE*	(+)	(—)	(+)	(+)		
Rh$_1$	*CDe*	+	—	+	—		
Rhy	*CdE*	(+)	—	(—)	+		
Rh'	*Cde*	+	—	—	—		
Rh$_2$	*cDE*	—	+	+	+		
Rh$_0$	*cDe*	—	+	+	—		
Rh"	*cdE*	—	+	—	+		
rh	*cde*	—	+	—	—		

Those reactions not yet determined serologically are given in brackets.

The three forms of allelomorphic antigens are arbitrarily denoted by C, c, D, d, E, e, chosen to avoid confusion with any symbols so far used. The antibodies with which these react are denoted by corresponding Greek letters. These single letters refer to antigens and their corresponding antibodies only. Every gene of the system seems to be associated with a selection of three antigens from these three pairs. The system thus predicts an eighth allelomorph, *Rhz*, which could not be recognized in a single individual, but could be identified in a favourable pedigree. It also suggests the possibility of two more antibodies not yet known reacting with d and e respectively.

Wiener[1] has supposed that the presence of the *Rh*$_1$ gene results in there being two "partial antigens" on the red cell (C and D of the table), and our recent work with *St* and other sera seems to make three parts necessary to the total antigen resulting from the *Rh*$_2$ gene, namely, c, D and E.

It is only one of these three antigens in the *Rh*$_2$ cells, called D in the table, which is being blocked by the anti-*Rh*$_1$ serum. E and c are left uncoated and ready for agglutination.

	Rh$_2$ cells untreated				*Rh*$_2$ cells coated with anti-*Rh*$_1$ serum			
Serum dilutions	1/1	1/2	1/4	1/8	1/1	1/2	1/4	1/8
Anti-*Rh*$_1$ serum (Γ)	—	—	—	—	—	—	—	—
Standard anti-*Rh* serum (Δ)	+	+	+	+	—	—	—	—
St serum (γ)	+	+	+	+	+	+	+	+
Anti-*Rh*$_2$ serum (H)	+	+	+	+	+	+	+	+

The coating of this same D antigen in *Rh*$_1$ cells can be demonstrated, but first it is necessary to remove the agglutinin (Γ) in the anti-*Rh*$_1$ serum for *Rh*$_1$ cells. This was done by absorption of the serum by *Rh'rh* cells which remove the agglutinin but not the coating factor, since these cells contain C but not the coatable antigen D. With the resulting absorbed serum, cells of the genotype *Rh*$_1$*Rh*$_1$ can be coated without agglutination confusing the result. There is no blocking of the antigen C in *Rh*$_1$ cells.

Absorption with untreated *Rh*$_2$ cells diminishes the agglutinin titre of standard anti-*Rh*, (Δ), anti-*Rh*$_2$ (H) and *St* (γ) sera. Absorption with coated *Rh*$_2$ cells diminishes the titre of anti-*Rh*$_2$ and *St* sera but not that of standard anti-*Rh* serum. Thus, absorption experiments confirm that in *Rh*$_2$ cells it is only the antigen D which is being blocked, E and c being left free.

The coating factor may be looked on as the standard anti-*Rh* serum antibody (Δ), which can combine with its appropriate antigen, but is defective in that it is not a suitable partner for the second stage of the antigen-antibody reaction which results in agglutination of the cells. It may be called an incomplete antibody (Δ'). Varying salt concentrations failed to produce agglutination of the coated cell suspensions, so did variations in the pH.

The incomplete standard anti-*Rh* antibody (Δ') has been found in good strength in four anti-*Rh*$_1$ sera (from *Rh* negative mothers) and in a weak amount in our remaining anti-*Rh*$_1$ serum (from an *Rh* negative mother). With the removal of the incomplete antibody, these five sera gained no fresh agglutinating range; they did not, for example, then behave as anti-*Rh'* sera. In other words, there is no complete standard anti-*Rh* serum antibody present which is being masked by the presence of the incomplete form of this antibody.

One standard anti-*Rh* serum in our collection contains the incomplete antibody (Δ') as well as the complete agglutinin (Δ). Titration results with this serum and *Rh*$_1$ or *Rh*$_2$ cells had previously given what was a puzzling and unique appearance—weak reactions, with intervening negatives, continuing up to a high dilution (1/1,000). Preliminary absorption with, say, *Rh*$_2$ cells removes the incomplete antibody leaving the normal antibody, which now gives strong reactions up to the same titre with more of the same *Rh*$_2$ cells. It seems as if the incomplete antibody wins the race for antigen.

Incomplete antibodies have been looked for but not found in three *St* sera, four anti-*Rh*$_2$ sera, one standard anti-*Rh* serum, two sera from normal *Rh* negative donors, and eleven sera from normal *Rh* positive donors. The appropriate antigen D in all cells so far tried has been coatable; the cells were *Rh*$_1$*Rh*$_2$ (1), *Rh*$_1$*Rh*$_1$ (3), *Rh*$_1$*rh* (3), *Rh*$_2$*rh* or *Rh*$_2$*Rh*$_2$ (6) and *Rh*$_0$*rh* (1). The incomplete antibody can be removed from serum by appropriate but not by inappropriate (for example, *rhrh*) cells, nor by saliva from an *Rh*$_1$*Rh*$_1$ A_1B secretor. Heating to 56° C. all the sera involved made no difference to the reactions.

I do not know of any similar phenomenon in hæmagglutination or hæmolysis. The inhibition by normal serum of the tissue hæmolysis of red cells recently reported by Magraeth, Findlay and Martin[3] is evidently of a very different nature. The inhibitor described by these workers was not species specific, whereas the incomplete antibody now being described is specific down to one antigen.

In bacterial agglutination a more striking resemblance is found in the agglutinoid phenomenon studied by Shibley[4]. The most obvious differences are that agglutinoid was made by partial heat denaturation of the serum and showed itself only as a zone of inhibition followed in higher dilutions by normal agglutination; whereas in the anti-*Rh*$_1$ sera, which had not been heated but stored at − 20° C., all the standard anti-*Rh* antibody was in the incomplete form while all the anti-*Rh*$_1$ antibody was in the complete form. The behaviour of anti-*Rh* sera, heated to 65–70° C., is now being investigated.

Very recently a sixth anti-*Rh*$_1$ serum has been found, locally. The incomplete antibody was present in good strength immediately after taking the blood.

R. R. RACE.

Medical Research Council,
Emergency Blood Transfusion Service.

May 17.

[1] Wiener, *Proc. Soc. Exp. Biol. and Med.*, **54**, 316 (1943).
[2] Race, Taylor, Cappell and McFarlane, NATURE, **153**, 52 (1944).
[3] Magraeth, Findlay and Martin, NATURE, **151**, 252 (1943).
[4] Shibley, *J. Exp. Med.*, **50**, 825 (1929).

Rh Antibodies in Human Sera: a New Variety

Human sera containing several varieties of *Rh* antibodies have been described[1]. These may be distinguished one from another by their reactions with *Rh*-positive cells, particularly with the rare types *Rh'* and *Rh"*. The reactions are shown below.

Serum	Cells			
	Rh_1	Rh_2	Rh'	Rh''
Anti-*Rh*	+	+	—	—
Anti-*Rh'*	+	+	+	—
Anti-*Rh"*	+	+	—	+
Anti-Rh_1	+	—	+	—
Anti-Rh_2	—	+	—	+
Serum-*Hi*	+	+	+	+

The sera anti-*Rh'* and anti-*Rh"*, confirming previous work, have been shown to contain two agglutinins: anti-*Rh* and anti-Rh_1 in the former case, and anti-*Rh* and anti-Rh_2 in the latter. Each individual anti-*Rh'* or anti-*Rh"* serum varies in its content of component agglutinins. In many cases the relative strengths of these agglutinins may be judged by titration of the original serum with the cell types shown in the table.

A maternal serum (*Hi* in table) was studied which reacted with nearly all *Rh*-positive cells. This mother had given birth to three children but none had survived. The mother was *Rh*-negative and the father subtype Rh_2.

Absorption of this serum with certain *Rh*-positive cells has shown that it contains three agglutinins, anti-*Rh*, and two others resembling in their activity anti-Rh_1 and anti-Rh_2. The paternal genotype is unknown but it may be Rh_0Rh_2, and the immunizing effect of fœtal erythrocytes of genotype Rh_0rh may be responsible for the appearance in this maternal blood of the agglutinins which react with *Rh'* cells. This is supported by the fact that anti-*Rh'* agglutinins have been found in the serum of a mother, Group *Rh"*, whose child, genotype Rh_0Rh'', was affected with hæmolytic disease.

The serum *Hi* reacts very strongly with cells of genotype *Rh'Rh"*. This genotype has been seen four times, twice in siblings.

F. STRATTON.

Regional Transfusion Service,
Manchester.

[1] Wiener, A. S., *Proc. Soc. Exp. Biol. Med.*, **54**, 316 (1943).

Sulphur-containing Amino-Acids and Jaundice

IN connexion with part of the recent note of Beattie and Marshall[1], which may give the impression that methionine has a strikingly beneficial effect upon patients suffering from so-called "post-arsphenamine" jaundice, we feel that the time has arrived to report very briefly some of our own results in a trial on similar lines started by us more than a year ago. Promise of its success was indicated by the literature; and it was felt that every therapeutic possibility should be explored in view of the high incidence of this serious complication.

More than 450 cases have now been studied, and the progress of individual cases has been judged both clinically and by determination of the rate of fall of the serum bilirubin level. Of these cases, more than three hundred had to be excluded from the present analysis because the jaundice was too slight or too long established for satisfactory demonstration of a therapeutic effect. The ultimate assessment has been confined therefore to the hundred and fifty most severe cases coming under observation early in the disease. Some of these were treated with cysteine (as the ester hydrochloride), 2 gm. daily, some with methionine, 2·5 gm. or 5 gm. daily, and some with casein, 60 gm. daily. Throughout the trial an appropriate proportion of cases was set aside as controls. All patients were kept in bed, and received the same diet. There were 57 controls, 41 cases treated with cysteine, 33 with methionine, and 19 with casein. A brief summary of the results is set out in the accompanying table.

	Total no. cases	Mean no. of days for serum bilirubin to fall below 4 mgm. %, with no subsequent exacerbation, counted from the onset of jaundice
Control	57	25·8
Casein	19	32 9
Cysteine	41	21·3
Methionine	33	19·7

PERCENTAGE OF CASES IN WHICH THE SERUM BILIRUBIN FELL TO BELOW 4 MGM. %, WITH NO SUBSEQUENT EXACERBATION, IN THE PERIODS STATED, COUNTED FROM THE ONSET OF JAUNDICE.

	Less than 14 days	14–20 days	21–27 days	More than 27 days	% down in under 3 weeks
Control	10	23·5	29 5	37	33·5
Casein	10 5	26	10·5	52	36·5
Cysteine	12	51	12	24	63
Methionine	22·5	48·5	22·5	6 5	71

The results given in the table have been examined statistically; they show that both cysteine and methionine had a significant but not remarkable effect on the course of the jaundice. These findings confirmed the clinical impression that the benefit, although definite, was not sensational under the conditions of these tests. The casein had no action. In view of the known methionine content of the latter, it is surprising that no effect was obtained, and it is hoped that further work will provide an explanation of the apparent discrepancy. A full report of this work is now being prepared for publication.

(This work was made possible by Major-General L. T. Poole and Brigadier T. E. Osmond, and by the willing co-operation of a large team of workers, among whom we may mention Major Lane for estimations of serum bilirubin, Dr. Stocken and Messrs. Whittaker and Spray (Department of Biochemistry, Oxford) for preparation of natural cysteine (from hair), the Ministry of Supply for the supply of synthetic methionine, and the Statistical Committee of the Medical Research Council.)

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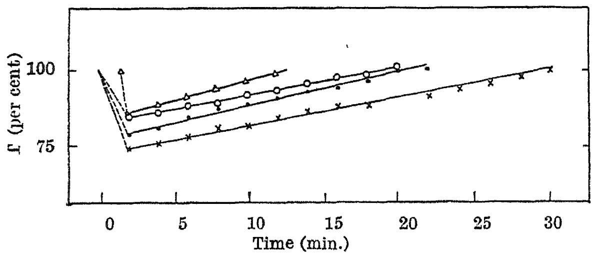
[1] NATURE, **153**, 525 (1944).

Adenosine-triphosphate Initiating Contraction and Changing Bi-refringence in Isolated Cross Striated Muscle Fibres

SINCE previous investigations[1] have demonstrated close relationship between myosin and adenosine-triphosphate, it seemed of interest to investigate the action of adenosine-triphosphate and related phosphorus compounds on living isolated muscle fibres.

So far we have used adenosine-triphosphate (isolated from rabbit muscle and purified several times through the mercury and barium salts), inorganic triphosphate, pyrophosphate and orthophosphate. All substances were used in iso-osmotic solutions of pH 7·3, part of the sodium chloride in the Ringer solution being replaced by an equivalent amount of the sodium salts of the substances in question.

Micro-application with micropipette and micro-manipulator[2] of adenosine-triphosphate in amounts of 2–3 $\times$ 10^{-1} μgm. on non-curarized and curarized muscle fibres initiates repeated, twitch-like contractions. These are accompanied by action potentials. Repeated application (with washing out in between) has the same effect.



DECREASE AND RESTITUTION IN PHASE DIFFERENCE (Γ) (ORDINATE) AFTER ELECTRIC TETANIC STIMULATION, —△—△—.

—o—o—, after application of 2·85 $\times$ 10^{-6} mol./ml. aden. triphos.

—·—·—, ,, ,, ,, 4·25 $\times$ 10^{-6} ,, ,, ,,

—×—×—, ,, ,, ,, 5·7 $\times$ 10^{-6}. ,, ,, ,,

Bi-refringence, examined by means of the Babinet compensator[3], falls 20–30 per cent after application of adenosine-triphosphate (1·2–7·3 $\times$ 10^{-6} mol./ml.) and recovers spontaneously in the course of 15–20 min. The degree of decrease and the duration of recovery depend on the concentration applied, and the time course corresponds closely to that observed after tetanic electric stimulation (see graph).

Cozymase (60 per cent preparation) in concentrations of 0·05–0·5 mgm./ml. is without effect either on the mechanical response or bi-refringence.

Preliminary experiments with inorganic *triphosphate* (6·1 $\times$ 10^{-6} mol./ml.) likewise show release of contraction of a more contracture-like type, the decrease in bi-refringence being only a quarter to a third of that occurring after application of adenosine-triphosphate.

Pyrophosphate in concentrations of 6·7–9·8 $\times$ 10^{-6} mol./ml. initiates contraction, and bi-refringence exhibits an irreversible fall of *c.* 40 per cent. Lower concentrations without releasing mechanical responses are accompanied by a decrease in bi-refringence the partial recovery of which takes more than 40 min.

Orthophosphate in concentrations of 2·5 $\times$ 10^{-5} mol./ml. likewise initiates contracture-like contractions, but no changes in bi-refringence occur.

The experiments indicate that: (1) In spite of the fact that different investigators[4] find that muscle membranes are impermeable to adenosine-triphosphate, it may react directly or indirectly with contractile and doubly-refracting elements. (2) Adenosine-triphosphate normally could be an agent of contraction, while adenosine-triphosphate present in muscle cannot be in immediate contact with the contractile elements due either to differences in local distribution or to the presence of a non-reactive compound. Addition of adenosine-triphosphate thus would correspond to the establishment of contact between adenosine-triphosphate and contractile elements otherwise initiated by the nervous impulse. (3) In contrast to findings with pure myosin, phosphorus compounds other than adenosine-triphosphate may release contraction and cause changes in bi-refringence.

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[1] Needham, J., Kleinzeller, A., Miall, M., Dainty, M., Needham, D. M., and Lawrence, A. S. C., NATURE, **150**, 46 (1942). *Stud. Inst. Med. Chem. Univers. Szeged*, edited by Szent Györgyi, A., 1 and 2 (1942, 1943).

[2] Buchthal, F., and Lindhard, J., *J. Physiol.*, **90**, *P* 2 (1937).

[3] Buchthal, F., and Knappeis, G. G., *Skand. Arch. Physiol.*, **78**, 97 (1938).

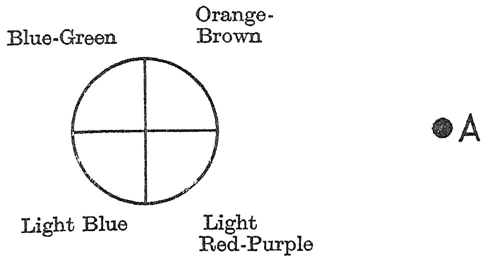
[4] Boyle, P. J., and Conway, E. E. J., *J. Physiol.*, **100**, 1 (1941).

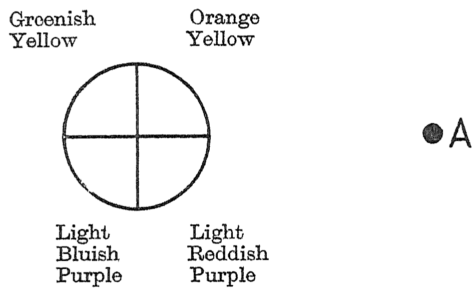
Colour of Small Objects

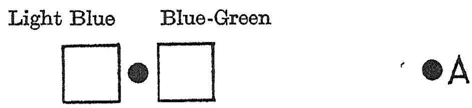
IF a circle, 2 cm. in diameter, is divided into quadrants and coloured as in Fig. 1, placed on either a black or white ground, and then viewed with one eye from a distance of about 3 m., it will be found that there is considerable difficulty in distinguishing the green from the light blue on one hand and the orange-brown from the light red-purple on the other, so long as the brightnesses of the fields are made as equal as possible. There will be no difficulty in distinguishing the green from the orange, provided that the observer is not red-green colour-blind in the sense that he habitually confuses such colours, and the circle will appear to be divided into two halves, right and left. Red-green colour-blind observers see the circle as uniform, or they may be able to separate the quadrants on subtle brightness differences.

Similar effects will be observed if the quadrants are coloured as in Fig. 2. The result in this case is even more striking since, if the circle is viewed at close range, it divides naturally into a yellow and green upper half and into a purple lower half. At a distance it divides vertically into a greenish-grey left half and a brownish-grey right half. It will be found that each particular green has its corresponding blue or mauve with which it is confused, and each yellow, orange or brown has its own particular reddish-purple.

In both cases, if the eye is focused not on the centre of the circle directly but on the point A, about 4 cm. from the centre of the circle, then all the quadrants stand out in their true colours. The point A may lie upon any radius of the circle. Similar effects are also obtained if the colours are arranged as in Fig. 3, so that they are probably not due to simultaneous contrast or to the overlapping of the images formed on the retina.







It may be inferred from these observations that under these conditions the centre of the fovea is not so good at distinguishing colours as the immediately surrounding area of the retina. The size of the circle is such that it corresponds closely to the so-called rod-free area. Both circle and external fixation point fall within the macula, so that the effect is probably not due to the macular pigment, which would perhaps be expected to act in a rather similar manner by cutting out the blue light. The confusions which occur at the foveal centre are almost exactly those made by the blue-blind person or tritanope[1], so that this area appears to be in some degree dichromatic and lacking in the blue sensation. This is not strictly true, since small objects seen at the centre of the eye may appear blue, but in this area the blue has no unique quality and, as has been shown, is readily confused with certain greens. The retina immediately surrounding the 'rod-free' area is normal and trichromatic.

Recently, the idea was put forward[2] that many of the data concerning colour vision could be explained in terms of two receptors, one the cone and the other the rod; that is, an element depending upon visual purple for its light sensitivity. It was pointed out at the time that this would lead to exactly the type of confusion which the above observations show to occur in the centre of the fovea. This area of the retina therefore perhaps consists of two elements, so far not distinguished histologically, but essentially corresponding to the cone and the rod, with the reservation that in this situation the latter does not accumulate visual purple or become dark-adapted as it does elsewhere in the retina.

Now Granit[3] has found that in the all-rod eye of the guinea pig the shape of the photopic visibility curve differs from that of the corresponding scotopic curve in such a way as to indicate that the retinal element in question acquires a relatively increased sensitivity to blue when light-adapted. If this change in relative sensitivity were dependent upon the 'bleaching' of the large quantities of visual purple in the dark-adapting rods, then this might provide a basis for a possible explanation of human colour vision on the following lines. The centre of the fovea may consist not only of cones but also of rods, the latter depending upon visual purple but not accumulating it. This area would therefore be dichromatic with the properties outlined previously. The rest of the retina would then depend on cones, on rods like those in the fovea, and on 'normal' dark-adapting rods which under photopic conditions would have a higher sensitivity to blue than the other rods and so act as a third receptor. In the red, yellow and green parts of the spectrum, both types of rods would have much the same sensitivity, and it is significant that from about 540 mμ to the red end of the spectrum all spectral colours can be matched by mixtures involving red and green only.

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[1] Pitt, F. H. G., *Proc. Roy. Soc.*, B, **132**, 101 (1944).
[2] Willmer, E. N., NATURE, **151**, 213 and 632 (1943).
[3] Granit, R., *Acta Physiol. Scand.*, **3**, 318 (1942).

Visibility of Blue and Yellow

IF a pattern consisting of blue and yellow areas be viewed at a sufficient distance by an observer, then, in certain circumstances, the blue is seen as black and the yellow is seen as white, so that the pattern appears to be a black and white one. Factors of importance in determining whether the pattern is seen as blue and yellow or as black and white have been found to be (1) the size of the pattern, (2) the intensity of illumination, (3) the size of the pupil, (4) the exact colours of the yellow and the blue pigments used in the design, (5) the adaptation of the retina, (6) spectral content of illuminant. It is suspected that factors of importance would also be (7) absorption of the eye media, and (8) absorption by the macula lutea.

Some quantitative measurements have been made in respect of factors 1, 2 and 3 (size, intensity and pupil diameter).

TABLE 1. EFFECT OF SIZE OF PATTERN.

3,000 ft. c. 1 mm. pupil

Visual angle (min. of arc)	Blue appeared to be:	Yellow appeared to be
3	Black	White
4	Black	White
5	Bluish Black	White
6	Blackish Blue	Cream
7	Blue	Pale Yellow
8	Strong Blue	Yellow

TABLE 2. EFFECT OF DIAMETER OF PUPIL.

3,000 ft. c. 6 min. of arc

Pupil Diameter	Blue appeared to be:	Yellow appeared to be:
1 mm.	Blackish Blue	White
3 mm.	Blue	Yellow

TABLE 3. EFFECT OF ILLUMINATION.

1 mm. pupil 6 min. of arc.

Illumination in ft. c.	Blue appeared to be:	Yellow appeared to be:
3,000	Blue	Yellow
1	Black	White

Of the three variables which have been tested so far, the change in the size of the pattern has most effect, and the change in the illumination has least effect on the colours seen.

The explanation of the disappearances of the colours appears to be as follows:

Both the blue and yellow pigments are greatly diluted with white light. Owing to the chromatic aberration of the eye, blue and yellow rays cannot be focused simultaneously. Therefore, if yellow images be sharp the blue images form wide diffusion circles; and vice versa. If the yellow images be sharp they fall on areas of retina which are already being illuminated by blue rays, and since these are complementary in colour to the yellow rays, the yellow is greatly diluted with white light, and this dilution increases as the pattern becomes smaller. If the blue images be sharp, it is these which suffer dilution with white light. If the eye be focused at an intermediate position, both blue and yellow images are slightly out of focus and each dilutes the other with white light. This dilution increases as the pattern becomes smaller.

The normal adjustment of the eye is that which produces sharply focused yellow images, and it is, therefore, these which become diluted with white light. In consequence, as the distance between the observer and a given pattern of blue and yellow increases, it is the yellow which first becomes confused with white. The blue images remain undiluted, but they suffer greatly in intensity, as Table 4 shows. It will be seen that down to the visual angle of 12 min. of arc, the fall in intensity of the blue is relatively slight, but that as the visual angle decreases to 3 min. of arc, there is a sudden fall in intensity. It is usually somewhere within this range that the blue is replaced by black.

TABLE 4. EFFECT OF VISUAL ANGLE ON LOSS OF INTENSITY OF GREEN, BLUE AND VIOLET RAYS.

Visual angle (min. of arc)	Percentage loss of intensity for: 5000 A.	4500 A.	4000 A.
24	3	5	9
12	6	10	18
6	12	20	36
3	24	40	62
1·5	48	63	78

The reason for considering the case for rays of 5000 A. is that blue pigments reflect or transmit these almost as much as they do the blue rays and the violet rays.

An increase in the aperture from 1 mm. to 3 mm. adds to the colours of the pigments the colours which are produced by the chromatic aberration of the eye. Consequently both blue and yellow become more visible; as shown in Table 2.

A decrease in illumination from 3,000 to 1 ft. c. decreases the visibility of the colours, because the amount of colour which is above the threshold of the foveal cones at a high intensity of illumination falls below that threshold at a low intensity, as shown in Table 3.

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Reproduction of the Woodlouse *Armadillidium vulgare* (Latr.)

DR. H. W. HOWARD, in his valuable studies on this isopod, has shown[1] that the sperms can be stored in the females for at least a year and still remain viable. Further, he records that "Eight virgin females have been isolated from any males for more than two years. In their second year three of these animals produced brood pouches in which eggs could be seen. The eggs, however, in all three cases failed to develop."

On June 29, 1943, I received from Dr. Hamilton E. Quick a number of specimens of this species referable to the variety *rufobrunneus* Cllge. All were adults and females.

One specimen was isolated and kept in a Petri dish. Although examined daily no change was observed until April 2, 1944, when it was noticed that it had developed brood pouches, and on April 22 ova could be distinctly seen with the aid of a lens (× 20). These ova hatched and were liberated on April 27. There were about fifty individuals. The smallest specimens were 1 mm. in length and the largest 1·5 mm. After the first moult, the measurements were 1·10 mm. and 1·15 mm., respectively, and at the end of seven days 1·20 mm. and 1·35 mm.

On April 30 the parent moulted and the progeny took possession of the exuviæ. All are still alive.

Examined on May 23, when just over three weeks old and after the second moult, no sign of red or brown coloration was apparent, and had I not known their history I should have identified them as young specimens of the variety *plumbeus* Lereboullet.

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May 25.

[1] *J. Genet.*, 85 (1940); 143 (1944). NATURE, 152, 331 (1943).

Reaction of Wheat Varieties Grown in Britain to Erysiphe

IN May 1944 a moderately heavy attack of mildew (*Erysiphe graminis*) developed in my wheat yield trial near Maldon, Essex. This trial consisted mainly of experimental breeding material, but since it also contained twenty rod-row plots of each of fifteen important commercial varieties of wheat, an opportunity arose of evaluating these varieties according to their susceptibility or resistance to mildew. Individual rows were classified on a scale of marks according to intensity of infection and the data subjected to an analysis of variance. These data are summarized in the accompanying table, a negative value indicating an attack of less than average severity and a positive value of more than average. Levels of significance are indicated where $P < 0{\cdot}05$.

Certain other commercial varieties were present in the trial in six replications only. Of these, the variety Picardie showed highly significant resistance (score $-6{\cdot}5$, $P < 0{\cdot}001$), but no other departure from the average was significant. There was, however, some indication ($P < 0{\cdot}10$) that the varieties Setter, Steel, Benoist 40, Red Drottning and Squarehead II were resistant, while Robusta, Redman and Vilmorin 29 were susceptible. No variety showed complete immunity to the disease.

Variety	Mildew score	Significance
Juliana	-2.9	$P < 0.01$ resistant
Iron III	-2.7	$P < 0.01$ resistant
Wilhelmina	-2.6	$P < 0.01$ resistant
Desprez 80	-2.5	$P < 0.02$ resistant
Weibull's Standard	-2.0	$P < 0.05$ resistant
Als	-1.3	
Garton's 60	-0.3	
Victor	0	Average
Steadfast	0	
Red Standard	$+0.1$	
Wilma	$+0.2$	
Yeoman I	$+1.5$	
Holdfast	$+2.3$	$P < 0.05$ susceptible
Little Joss	$+3.3$	$P < 0.01$ susceptible
Warden	$+9.3$	$P < 0.001$ susceptible

While mildew is not a factor of major importance in determining yield of wheat under British conditions, these data are of interest since, so far as I am aware, no numerical data of similar scope have previously been published.

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White Plumage of Sea-Birds

IN recent correspondence, Craik[1] has suggested that the white plumage of gulls and some other sea-birds might be an advantage to them by rendering them less visible to the fish on which they prey. This interpretation was questioned by Pirenne and Crombie[2], partly on the grounds that it is by no means certain that fish can see birds in the air, whatever their colour. This uncertainty, however, does not arise in the case of birds of prey which hunt over land, for these are undoubtedly seen by their prey. The reactions of other birds to a passing hawk have often been described. It would seem, therefore, that if a white under-surface were of adaptive value to birds which hunt against a background of sky, this form of cryptic coloration would be found among predaceous land-birds. Yet none of the eagles, hawks or owls have the pure white plumage of gulls. Some are certainly very pale on the under-surface, but there does not seem to be a greater tendency among these birds to have light-coloured under-parts than there is among other land-birds.

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[1] Craik, K. J. W., NATURE, 153, 288 (1944).
[2] Pirenne, M. H., and Crombie, A. C., NATURE, 153, 526 (1944).

The Hole Theory of Liquids

RECENTLY, Fürth[1], in a series of papers, has developed the hole theory of the liquid state. A liquid is regarded as a continuum permeated by a large number of holes, the number of holes being comparable to the number of particles in the liquid. The motion of the holes in the material continuum is similar to that of particles in a gas, and the hole theory on this account has a formal similarity with the kinetic theory of gases. A hole has four degrees of freedom, three of translation and one corresponding to a change in its radius. The average period for radial oscillation of holes is found to be

$$\Gamma_0 = 0 \cdot 17 \frac{\rho^{1/2} (kT)^{3/4}}{\sigma^{5/4}},$$

which is of a far smaller order of magnitude than the meanlife Γ of the hole. σ represents the surface tension of the liquid, ρ its density, T the temperature and k is Boltzmann's constant. The meanlife as discussed by Fürth is the time for which a hole lasts before it is destroyed by evaporation of molecules into it. In determining the meanlife, Fürth has neglected the effect of curvature on the rate of evaporation. When this is taken into account, the hole theory affords a simple though, because of its inherent defects, not quantitatively accurate description of the variation of viscosity of liquids with pressure. For example, for pressures smaller than p_2, the internal pressure of the liquid, we have

$$\log_e q = \frac{0 \cdot 54 M}{\rho R T} p,$$

where q is the ratio of the viscosity under pressure p(kgm./cm.^{2}) to that under atmospheric pressure, M the gram molecular weight, and R the gas constant. For most liquids p_i is of the order of 10^3 kgm./cm.^{2}.

It is interesting to observe that (on certain assumptions) the thermal conductivity of a liquid can be connected with the period of the radial oscillations of a hole. We find that the theory requires

$$C \equiv 2\chi/\rho^{1/2} S (\sigma k T)^{1/4}$$

to be a constant and equal to *unity* for all unassociated liquids. In the above expression, χ is the thermal conductivity and s the specific heat per unit mass. The accompanying table gives the observed values for C—the average value for non-metallic liquids is about twice the theoretical value. In the case of metallic liquids, the observed value for C is of the order of 10^2; this is as it should be, for in metallic liquids the conductivity is due to electrons and the hole theory is inapplicable.

Substance	Temperature (T°K.)	Thermal conductivity, χ (watts/cm. deg.)	Specific heat, S (joule/gm.)	Surface tension, σ (dyne/gm.)	C
Mercury	273	8360	0·14	466	158
H_2O	293	587	4·18	74·2	2·1
C_6H_6	293	170	1·7	28·9	2·1
CCl_4	273	110	0·84	28·0	2·0
C_6H_2O	273	180	2·0	44·0	1·6
CH_3OH	293	209	2·5	22·6	1·9
CS_2	293	161	0·96	33·8	2·7
$CHCl_3$	285	138	0·95	28·5	2·3
$C_4H_{10}O$	293	138	2·29	17·0	1 5
C_3H_6O	293	179	2·21	23·7	1·8

The full account of this work will appear in the *Proceedings of the National Institute of Sciences, India*.

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[1] Fürth, R., *Proc. Camb. Phil. Soc.*, 37, 252 (1941).

Deformation of Rubber-like Materials

IN a recent paper on the highly elastic deformation of polymers, Aleksandrov and Lazurkin[1] give the following expressions, first for the total deformation $D(t)$ of rubber at time t after application of a constant stress:

$$D(t) = D_0 + D\infty\ (1-e^{-t/\tau}), \quad . \quad . \quad . \quad . \quad (1)$$

and second, for the amplitude D of deformation under a harmonic stress:

$$D = D_0 + \frac{D_\infty}{1 + i\omega\tau}; \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

where D_0 is the 'ordinary elastic' component, very small compared to D_∞; D_∞ the 'highly elastic' component, obtained for $t \to \infty$ in (1) or $\omega \to 0$ in (2); ω is $2\pi \times$ the frequency of the applied stress; τ a 'relaxation time'.

It may be noticed that expressions (1) and (2) would be given by the mechanical model shown in Fig. 1, where K_0 is the stiffness of a spring corresponding to the 'ordinary (crystal) elasticity'; K_∞ one corresponding to the 'high elasticity'; R the 'damping coefficient' of a dashpot in parallel with the spring, giving rise to a viscous force proportional to the velocity. When a constant force F is applied to the system, the solution of the equation of motion gives the displacement:

$$D(t) = \frac{F}{K_0} + \frac{F}{K_\infty}(1 - e^{-tK_\infty/R}); \quad . \quad . \quad (3)$$

while for a harmonically varying force $Fe^{i\omega t}$ the steady state solution is a harmonic displacement of frequency $\omega/2\pi$ and amplitude D:

$$D = \frac{F}{K_0} + \frac{F}{K_\infty + i\omega R} \quad . \quad . \quad . \quad . \quad . \quad (4)$$

(3) and (4) reduce respectively to (1) and (2) on writing $D_0 = F/K_0$; $D_\infty = F/K_\infty$; $\tau = R/K_\infty$.

If one considers a rubber unit stressed, for example, in shear, it is easy to see on introducing an elastic modulus G and a 'normal viscosity coefficient' ν (cf. Kimball[2]) that the 'relaxation time' τ has the expression

$$\tau = R/K_\infty = \nu/G \quad . \quad . \quad . \quad . \quad . \quad . \quad (5)$$

It is of interest to compare the results of Aleksandrov and Lazurkin with those of other workers using the free or forced vibrations of tuned systems, as shown in the mechanical model of Fig. 2. The 'ordinary' elasticity was neglected by these authors ($1/K_0 = 0$); a justifiable approximation for the type of polymers and range of temperatures in their work.

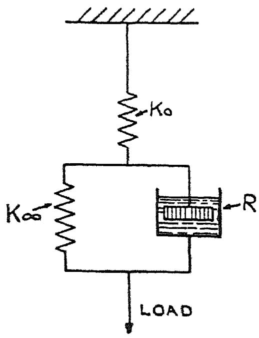

Fig. 1.

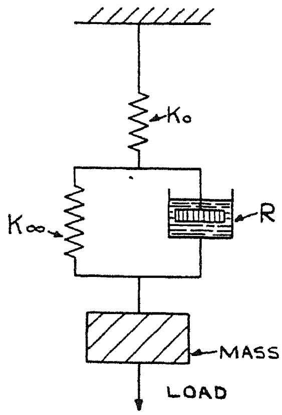

Fig. 2.

An advantage of the tuned system method is that it permits the separate determination of elastic and viscous forces. The elastic modulus is determined from the frequency of the free vibration[3], or from the frequency of resonance of the forced vibration[4,5]. The viscosity coefficient is determined from the rate of decay of the free vibration[3], or from the amplitude at resonance of the forced[4,5]. The 'relaxation time' is then determined from Equation 5: $\tau = \nu/G$. Now all the authors quoted[3,4,5] have found that G varies little, if at all, with frequency, while ν is roughly inversely proportional to frequency. This fits in better with the phenomena of elastic hysteresis connected with ordinary elastic solids (cf. ref. 2) than with the notion of a 'relaxation time' constant at a given temperature. In order to connect these results with the 'freezing up' of rubber with increased frequency observed by Aleksandrov and Lazurkin, one would expect the curve of τ versus frequency to start at low frequencies roughly in the shape of a rectangular hyperbola, but tend asymptotically with increasing frequency to a constant positive value. The determination of G and ν over a wide range of frequencies and temperatures would not only be of theoretical interest, but also of great practical value in the engineering application of rubber. One further point that is best brought out by the forced vibration method is the departure from linearity of elastic and viscous effects in rubber: it is found that the measured values of G and ν vary with the amplitude of strain.

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Metalastik, Ltd.,
Leicester.
April 27.

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[2] Kimball, A. L., *Trans. Amer. Soc. Mechan. Eng.*, **51** (1), 227 (1929).,
[3] Harris, C. O., *J. Appl. Mech.*, **9**, 129 (1942).
[4] Naunton, W. J. S., and Waring, J. R. S., *Proc. Rubber Tech. Conf.* London, May 23–25, 1938, 805.
[5] Gehman, S. D., Woodford, D. E., and Stambaugh, R. B., *Ind. and Eng. Chem.*, 1032 (Aug. 1941).

Solubility of Basic Open Hearth Slags

A CONSIDERABLE amount of work has been done, over a number of years, regarding the phosphate solubility of basic open hearth slags. The *Proceedings of the Faraday Society* of 1920 contains "A Symposium on Basic Slags" giving much data regarding the subject of phosphate solubility.

Our investigations, commenced in 1920, employed pieces of basic finishing slag, in lump form (Fig. 1) instead of the powdered samples used in the original work. These sample pieces of slag have been subjected to extraction in 5 per cent hydrogen chloride solution, the acid solvent being changed at 24-hour intervals and analyses made on the contents of these soluble portions, these results representing the daily extraction.

This method of extracting revealed an interesting fact, namely, that when the acid extraction was complete, a practically pure silicious resdeue (Fig. 2) remained in the beaker. The residue was of similar shape and size to that of the original slag lump, but was in appearance of a porous skeleton nature.

The rate of solution of the different constituents is also informative, as shown in Fig. 3. The extraordinary feature is the residual matrix of practically pure uncombined silica (Fig. 2). The chart gives the relative solubility rates of typical slag lumps extracted by a 5 per cent hydrogen chloride solution.

Reproducible results can be obtained on various basic open hearth finishing slags, irrespective of their origin.

The above experiments led us to use a similar extraction method on transparent, glassy, amber-coloured slags extruded into the cavity at the head of large forging ingots of acid open hearth steel. The typical analysis of these slags is as follows:

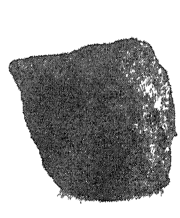

Fig. 1.

Fig. 2.

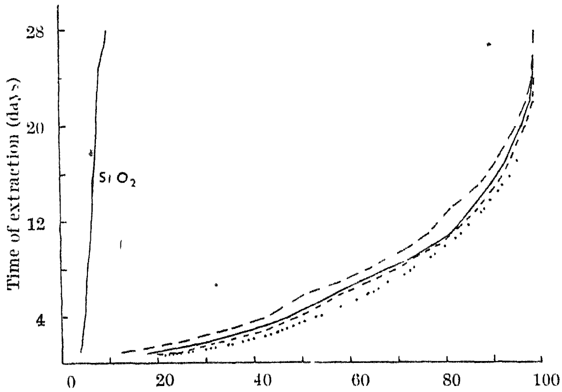

Fig. 3. SOLUBILITY OF LUMP BASIC SLAG IN 5 PER CENT HYDROGEN CHLORIDE SOLUTION.
Fe, ———— ; CaO, - - - - - ; MnO, ... ; P_2O_5, — — —.

silica, 45·51 ; ferrous oxide, 0·90 ; alumina, 23·10 ; manganese oxide, 28·52 per cent.

When extracted by warm, concentrated hydrochloric acid, these slags yield white, glossy residues of pure silica.

Further interesting phenomena were observed during an investigation dealing with hæmatite iron ores. Ordinary lump ore samples when extracted in concentrated hydrochloric acid, as above, leave a rigid porous skeleton of pure silica ; this residue has a crystalline appearance. Samples of kidney and pencil ores from the same mine, when thus extracted, leave the silica in a laminated, transparent, gelatinous form.

The information, here available, may shed some light on this very obtuse problem and be of value to future investigators.

B. W. METHLEY.
H. J. TURNER.

Steel, Peech and Tozer,
The Ickles,
Sheffield, 1.
May 4.

Non-Solar Planetary Systems

IN his communication in NATURE[1] on non-solar planetary systems, Sir James Jeans writes, "Mr. Sen refers with approval to Banerji's modification of this [tidal] theory. This makes the original sun a Cepheid which had its oscillatory instability increased by the gravitational attraction of a passing star. But a passing star cannot increase the instability of a Cepheid appreciably unless it comes very near. . . . Judging from their luminosity, all Cepheids are much more massive than the sun or 61 Cygni or 70 Ophiuchi."

In my paper[2] on "The Instability of Radial Oscillations of a Variable Star and the Origin of the Solar System", I have given a theory which, I believe, satisfactorily accounts for the amount of angular momentum and energy possessed by the planets. The sun is supposed to have been originally a *part* of a Cepheid variable much heavier than the sun, which oscillated radially with small amplitude. It has been shown mathematically that the oscillations are stable only if the amplitude is so small that its square may be neglected. Instability will ensue if the amplitude is increased so that its square can no longer be neglected. The nearby passage of a star of about the mass of a Cepheid increased the amplitude of the oscillations, rendering them unstable. Matter was consequently thrown out, which condensed into the sun and the planets. If the parent Cepheid had a mass about nine times that of the sun, the sun and its planets would take away about two fifths of the Cepheid's energy. It has also been shown that the encounter need not be "very close", nor need the intruding star have an inordinately large velocity to give the requisite angular momentum to the sun and the planets and enough energy to the solar system to escape from the parent Cepheid. It appears that due to the difficulties of transit at present, Sir James Jeans has not perhaps seen my paper.

Jeans has also suggested[3] that the sun was originally big enough to include the orbit of Uranus and yet not too diffuse to hang together dynamically. There are several difficulties in such a theory which cannot be explained satisfactorily. The angular velocity imparted to the surface of the primitive sun extending up to the orbit of Uranus will presumably be of the same order as the angular orbital speed of Uranus. If the sun contracted from its enormous original size to its present dimensions, its angular velocity should increase considerably. Even granting that 98 per cent of the original angular momentum has been taken away by the planets, a little calculation will show that the sun should be rotating with at least 400 times its present angular velocity and should on that account become *distinctly* spheroidal in shape.

Moreover, with such rapid rotation, possibly the critical value for $\omega^2/2\pi\gamma\rho$ will be reached, and there will be equatorial break-up, resulting in the formation of rings of particles surrounding a central lenticular mass. Again, if the planets had taken away 98 per cent of the total angular momentum as calculated on the above theory, they should be revolving much more rapidly at present.

Another point in this theory may also be mentioned. Jeans supposes that the planets are most likely to have been formed before the sun's radius fell much below 4,000 times its present radius. It is difficult to understand what processes might have helped to bring the innermost planets to their present distances of the order of 100 times the sun's radius.

Sen has referred in his communication in NATURE[4] to the well-known Jeans-Jeffreys theory, from which it follows that planetary systems should be of "the nature of freak formations"[5]. It seems that he did not refer to Jeans's recent communication in NATURE[1], as the suggestions there are "very tentative".

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[1] NATURE, 152, 721 (1943).
[2] Banerji, A. C., *Proc. Nat. Inst. Sci. Ind.*, 8, 173 (1942).
[3] NATURE, 149, 695 (1942).
[4] NATURE, 152, 600 (1943).
[5] Jeans, J. H., "Astronomy and Cosmogony", 401 (1928).

APPLICATION OF GENETICS TO PLANT AND ANIMAL BREEDING

THE Genetical Society held a symposium on the "Application of Genetics to Plant and Animal Breeding" in London on April 13. The president, Dr. C. D. Darlington, in opening the meeting, said that genetics owes a debt to plant and animal breeding both for its foundation and its development. If the purpose of agriculture in the future is to be the highest production, genetics will have the opportunity of repaying this debt. The object of the symposium was to discuss whether genetics has the capacity to do so.

Mr. M. B. Crane, dealing with fruit and forest tree breeding, said that the production of new varieties, and the maintenance and efficient use of old ones, are problems within the scope of our present genetic knowledge. The first essentials for improvement are a knowledge of modern techniques and of the variation, relationship and distribution of the plants and trees within the different groups. Without this knowledge the breeder would often be working in the dark and be likely to follow some of the old traditions, such as breeding from the best for the best, often to find that this does not work.

The cost of fighting the diseases and pests of fruit, as of other crops, can be largely saved by the establishment of resistant and immune forms, so far attempted only on a small scale. Many crops are susceptible to injury by the sulphur, copper and other drugs used to combat diseases. It is known that immunity to this injury is often heritable. Advantage is likely to be obtained by the replacement of continuous vegetative propagation by sexual propagation. The devastation wrought by virus disease on the growth and yield of raspberries and strawberries, and the common freedom of seedlings from serious infection for a profitable time might be turned to account. The uniformity of healthy clonal reproduction would not be surpassed, but, in the clone, virus gives rise to great variability and decline in yield, quality and growth.

In apples and pears about a third of the varieties are triploids. This means that they have been favoured by selection. In the past we have had to depend on their spasmodic occurrence. In pears triploid families can now be raised at will, and the breeding and induction of tetraploids is likely to give new forms of outstanding value. To get the best from new polyploid fruits, new polyploid root-stocks might have to be made to fit them. In addition to old varieties, new wild stocks of useful species should be collected and established for the breeders' use, to introduce frost and disease resistance and high nutritive value and to maintain hybrid vigour and variability.

In our farm and garden crops selection and breeding have given us many improved forms which have long ago displaced most of the original wild forms from cultivation. In Great Britain, practically no such improvement has been made or even attempted with forest trees. It seems to be assumed that with est trees technique would be difficult, and selection breeding work inevitably prolonged. In the ed States and in Sweden, however, both selection reeding of forest trees have been carried out ecisive results in a short time. Selection for and quality has been effective, and important ers such as frost resistance and rapidity of growth have been combined by hybridization. The efficiency of new afforestation programmes will depend on the use made of genetics.

Prof. H. G. Champion indicated the great scope for the practical application of the genetical knowledge which can be gained about our important forest trees. He said it is exceptionally wide in Great Britain owing to the general reliance on plantations for regenerating or creating forests, and to the widespread use of exotic species. The consequences of mistakes made in selection of the stock used in any locality will carry on for at least a tree generation. Relatively little intensive research has been done on forest trees; but there is ample evidence that the majority of the factors most important to foresters both in growing their forests and in the quality and quantity of their final yield vary to an important extent with genetic constitution.

The older work has been mainly the comparison in various localities of results obtained with collections of seed made in different parts of the geographic range of the species concerned. This work has demonstrated that differences often occur so marked that on the right choice might depend outstanding success or complete failure. Such studies cover all the common species but have given particular attention to *Pinus sylvestris*. More recently, attention has been paid to controlled pollination both to ensure homogeneity and to study the results of crossing both within a species and between species. Examples of commercially important hybrids and polyploids are available, notably with Larix and Populus.

Genetical research on forest trees and the practical application of results present special difficulties as compared with similar work on other plants. These have probably been over-emphasized, but are the main cause of the relative neglect under which the subject has suffered at the hands of botanists and practical foresters. These difficulties were briefly reviewed. For research, they derive from the large size of the tree unit, the late maturation and inaccessibility of the flowering branches, and the fact that growth in crops is essential for proper assessment. In application of results, these same hindrances are involved and, furthermore, most forest trees cannot easily be multiplied vegetatively. Considerable progress has already been made in surmounting these obstacles and it is thought that many of the problems should be capable of solution; organized attack with official support is strongly to be recommended.

Prof. T. J. Jenkin explained the conflict that existed before genetic methods were applied to grass breeding. The grassland farmer wanted a permanent sward, and the seedsman selected for abundant seed; but the two are incompatible. More recent work has been directed mainly towards improvements in yield, particularly in the form of hay, and it was not at first realized that practical grass-breeding involves at least two distinct problems, of which the simpler and less important is this increased hay yield. The second, and the more important under Welsh conditions, is the production of persistent and productive strains that will stand continuous grazing over a period of years. The grasses, even apart from their heterozygosity, are not good subjects for formal genetical studies (except where defective seedlings are concerned) because they present very few characters that can be easily observed in the mature plant. The important characteristics such as growth habit, tillering capacity, persistence of the individual plant,

time of flowering, growth and productivity and so on are presumably extremely complex, and a satisfactory method of studying them is greatly needed. At the same time, the grass breeder should not completely neglect formal genetics, and particularly should a general genetical survey of plant material be made if only in order that a more definite estimate of the total heterozygosity of the various species might be made.

Dr. G. D. H. Bell pointed out that the most obvious contribution which genetics can make to the breeding of crop plants is to improve the efficiency of selection of parental material, and of the desired genotypes in mixed or hybrid populations. Many of the attributes which determine the agricultural and economic value of a crop are of a complex nature, showing the general characteristics associated with quantitative or polygenic inheritance, and improvement depends on the accurate genotypic selection of the most desirable combinations of these attributes. Therefore, although more knowledge is necessary concerning the genetics of quantitative characters in general, and of certain 'breeding characters' in particular, it is necessary to realize that the latter require careful definition and resolution in relation to their morphological and physiological components before genetic analysis is attempted.

Where crop improvement is dependent largely on hybridization, its efficiency is dependent, first, on the correct choice of the parental material, and it is essential to have knowledge concerning the breeding value of the material available, and the possibilities of combining characters which might show physiological incompatibility. This is a matter of considerable importance in any scheme of hybridization which involves a progressive synthesis of components affecting the expression of a complex character.

Accurate genetical investigation is dependent on the reasonably easy recognition of genotypes and genotypic variation. The difficulty in plant breeding which involves field selection is the assessment of the individual, or of a small progeny, when several characters are concerned and each is affected to varying degrees by the environment. Attempts have been made to develop selection indices for improving the efficiency of field selection; but there are considerable difficulties in the application of such methods to any reasonable amount of breeding material. However, it is in relation to the above considerations that any further contributions on the part of genetics to plant improvement must be considered.

Dr. K. Mather remarked that the progress of genetics has not yet led to the marked advances in plant and animal breeding which has been so confidently expected in the past. He pointed out that it will be necessary to determine which branches of genetical study are directly concerned with the problems of breeding, and deliberately to foster investigations of these kinds. They must aim primarily at increasing the precision with which the tools of the breeder—selection, adjustment of the mating system, and adjustment of population size—can be used to manipulate the heritable variation which constitutes his raw material.

The first necessity is a knowledge of the type of inheritance involved in breeding for any particular character, and this is not yet available in all cases. Where inheritance is simple, depending on major genes, genetics can already supply the information necessary for estimating the progress which might be expected, for determining how to plan the breeding programme, and for calculating its magnitude. The great majority of characters involved in breeding programmes, however, show polygenic variation, depending on many genes having small, similar and supplementary effects. Such genes determine a type of inheritance different from and more complex than that depending on major genes. Furthermore, they cannot be individually identified owing to the masking effects of one another and of non-heritable variation. Genetics has in the past offered little help in handling polygenic variation; but recent investigations are changing this situation. Methods are now available for separating and estimating, from F_2 and F_3 data, the non-heritable, fixable genetic, and unfixable genetic, parts of the variation in crosses, and so of gaining an idea of the progress which can be expected from them. The action of selection on such systems of variation is also being elucidated, as is the response of variation to changes in mating system. These advances have been made possible by the application of statistical methods developed during the past fifteen years, and further progress in this field will depend on the close co-operation of geneticists, breeders and statisticians.

Dr. Mather concluded by discussing the possibilities of building up new systems of variation through species crossing and polyploidy, and of inducing new and desirable variation by experimental means.

Turning to cattle breeding, Dr. H. P. Donald pointed out that the evolution of breeds is controlled by the isolation and size of populations, random fluctuations in gene frequency, and selection. Isolating factors at work both within and between breeds include pedigree registration, closed herds, attestation, geography and breeding objective. Within breeds, however, the rate at which breeding stock, especially bulls, are exchanged between one partially isolated group and another must reduce the effects of the isolation and prevent the growth of locally adapted types. The small size of many herds retards selection. In one breed, about 70 per cent of the herds are estimated to have fewer than twenty-five calved cows or heifers. The number of bulls in use is correspondingly small, and the result is that the herd is subject to random fluctuations in gene frequency, that the stockbreeder is obliged to purchase bulls, and finds difficulty in discriminating against unsuccessful sires. The constant process of dispersal of established herds and their replacement by new ones results in a herd-age distribution somewhat resembling the age distribution of animals themselves. There are many herds which have had opportunity to practise selection for only three or fewer generations. About 60 per cent of the herds in a sample of 475 herds in one breed of dairy cattle have been breeding pedigree animals for seventeen years or less. This immaturity of so many herds must also markedly reduce the amount of effective selection being practised within breeds.

Dr. A. Walton said the main function of the animal in farming economy is the conversion of available raw materials, unsuitable or less suitable for direct human consumption, into products whic[h] can be directly consumed. It follows from this t[hat] as techniques of production improve, not only [does] the standard of the product rise but so also do[es the] standard of nurture of the animals supplyi[ng the] product. Livestock is improved as a direct r[esult of] better nurture. Improvement might be inde[pendent]

of any change of genotype, although the expression of the genes might be considerably altered. In the past, improvements due to both nurture and genetic selection have proceeded simultaneously and it is impossible to evaluate either separately. Livestock improvement is not the simple sum of improved nurture plus genetic improvement but is more nearly expressed as the resultant of the two factors acting together. If genetic selection is applied to a heterogeneous population maintained at a constant level of nurture some improvement might result from the isolation and combination of major genes. There will be an approach to homozygosity and genetic stability, and the level of nurture will set a limit to any further improvement. If the standard of nurture of a heterozygous population is raised, there will be increased differentiation of genotypes, and selection (whether conscious or natural) will proceed more rapidly than on a lower plane but eventually the same condition of stability will be reached. By feeding animals individually and successively raising the plane of nurture, and by selecting those genotypes which respond, the breeder directs the evolution of superior strains. In the past, nutritional research and genetics have been carried out in isolation. Livestock improvement requires the combined attention of both nutritionist and geneticist.

Dr. J. M. Rendel argued that, owing to the division which exists between commercial and stud breeding in animal husbandry, attempts to improve stock are handicapped in two ways.

(1) The size of the effective breeding population is reduced to approximately 1,250 males and 30,000 females per breed in sheep, 180 males and 5,000 females in cattle, and 70 males and 1,000 females in pigs, these being the populations required to provide sires for the commercial breeders; the universal introduction of artificial insemination will reduce the size of stud populations, if the present organization is kept, to ridiculously small numbers. In such small populations the variability upon which selection depends is reduced and recombination of genes in any particular way is made more difficult; the comparatively small size of flocks and herds of sheep and cattle may account for the restricted lines along which each breed has been improved as compared to the Rhode Island Red, which, with a prewar population of twenty million, combines good table qualities with a very large egg production.

(2) There is reason to believe that if selection is carried out to produce a given character in two different environments, two different sets of genes will be selected, neither of which would produce the desired result if the environments were interchanged; thus, where stud breeders are selecting in an environment different from the one the commercial farmer will provide, they are selecting animals in a direction not best suited to the commercial breeder. The distinction, therefore, between commercial and stud breeding should go, and populations made up of whole breeds, working under uniform environmental conditions, be treated as one unit for breeding purposes.

Prof. R. A. Fisher said that the production of *élite* breeding stock is a different matter from its ssemination or its utilization. In the period of dern genetics, the traditional procedure of selective ding has been shown to be capable of great ration by the use of objective tests of perice, developed chiefly abroad. Progeny tests ere included, for they are only performance tests applied to relatives, usually daughters, of the animals selected. Unfortunately, they can only be applied to the minority, the great majority having to be eliminated on other grounds.

It should be remembered in this regard that mothers are as closely related as daughters. The only difference is that there are fewer mothers. The advantage of using daughters for performance tests depends, therefore, on their correct statistical treatment.

Recording societies do valuable work in testing performance in practical conditions of animal husbandry, but the conditions are highly variable. There is need for selective livestock improvement centres equipped to carry out tests with some experimental refinement. These could issue certificates of performance, and should be associated with selective breeding projects (Prof. Fisher personally favouring dual-purpose projects), with the central organization of recording activities, and with artificial insemination units. Artificial insemination alone, however, can do little towards livestock improvement, unless based on the use of objectively tested stock. Price is no criterion.

The genetic personnel available is so limited for any serious programme of livestock improvement that specialization will be essential. The problem of improving the objective tests so far used in respect of precision, for the two objects of (*a*) assessing the commercial value of a farm animal, and of (*b*) assessing its breeding value, is too technical and intricate to be added to the responsibilities of the livestock improvement centres. There is need of a single laboratory charged solely with the study of these tests, with the view of increasing their precision in these two respects. In addition to the published literature, it should in time be able to draw valuable data from the experience of carefully planned selective improvement projects carried out with the best available types of livestock.

For the sake of brevity, Prof. Fisher omitted reference to the very extensive, important and successful work carried out in hybrid corn programmes in the United States; as this was referred to in discussion, he added that he regards the experience gained in this field in the last twenty years as of the utmost consequence, especially to animal breeders.

In the discussion, Dr. A. E. Brandt explained that twenty years ago maize yields in the United States were no higher than those produced by the Indians before the discovery of America. Breeding improvement had no more than made up for soil deterioration; but lately a great change has taken place. From 10 million acres of maize in Iowa in 1933 the yield was 37 bushels per acre; in 1942 it was 62 bushels per acre, both without fertilizers. Two thirds of the increase was due to the use of hybrid seed produced for local conditions.

Touching this question, Dr. S. Ellerton said that breeders would sometimes maintain that a particular crop or animal has been so highly bred that further genetical improvement would be so slight and so difficult as not to be worth while. This was said of maize before the introduction of hybrid combinations of inbred lines. It has been said of cattle in the U.S.S.R. and of cereals in Great Britain. In his opinion, such apparent 'genetical limits' are merely imposed by the shortcomings of current breeding methods and would prove to be false, as was clearly so in maize. In the case of wheat he had some evidence. In 1943 he tested forty-two F_1's involving

he b(ıt varieties against their parents ınd e ,verage ıncrease in the hybrids of 10 pe 'ɔer of ears per plant and 4·6 per 'ent i ɔrain per ear, a total increase of 5 pe1 l of grain. Some individual crosses wou… ,how more heterosis than others, so that this strongly suggested that wheat could be bred for British conditions with yield increases of 20 per cent at least.

Dr. J. S. Huxley and others stressed the need for physiological and genetical examination of practical breeders' data, which are now available.

Prof. J. B. S. Haldane pointed out the importance of natural selection in domestic plants and animals and of undesirable selection for high seed number, or for longevity; the fallacy of assuming that in-breeding necessarily leads to homozygosis; and the danger of standardized clonal reproduction leading to epidemics.

Mr. W. J. C. Lawrence said that ultimate progress in plant breeding would often depend on the selection for efficiency of specific nutrient intake, for rich soils as well as for poor unbalanced ones. In this regard Dr. G. D. H. Bell discussed the need for combined manurial and variety trials for selection under local and good conditions.

Dr. F. Yates directed attention to the importance of testing new varieties of agricultural crops under a wide range of environmental conditions. Varieties might vary considerably in their reactions to different weather conditions, different soil types and different nutrient supplies in the shape of fertilizers. Thus, for example, one of the biggest factors limiting the yield of cereals in Great Britain is their inability to stand up to high levels of nitrogenous manuring without lodging. Modern developments in the technique of experimental design, in particular the development of factorial experiments, which enable several factors to be tested simultaneously (for example, varieties and different fertilizer components), provided the necessary machinery by which such tests can be efficiently made. It is equally important to carry out the tests at a number of different centres and over a number of years, so as to obtain adequate variation in weather and soil conditions. Any experimental programme of this type necessarily involves a large number of co-ordinated experiments. The organization required for the efficient execution of such experiments has not yet been fully developed, but there is now good prospect of radical improvement in this respect. It is of the utmost importance that the plant-breeding interests should be adequately represented, and should lend their full support to the development of such a co-ordinated programme.

Dr. Darlington, summing up, said that the papers showed an important contrast in treatment between two levels of breeding practice. On one hand there is the situation where common sense alone will sufficiently indicate the breeding programme in its initial stages. This is particularly true in undeveloped conditions and those where negative selection has been practised. Examples have been described in grasses and forest trees where commercial practice favours quantity of seed rather than quality of fodder or timber, and in cattle-breeding when the breed society, founded to improve cattle, has become organized to prevent improvement, a condition which will obviously be broken down by the spread of artificial insemination. No more economical or fruitful programme of genetical research in cattle-breeding could be suggested than the long-neglected survey of actual breeding practice and performance in Great Britain to-day, the outlines of which were indicated by several speakers. At the other extreme is the situation of the highly developed breeds of poultry and varieties of cereals where maintenance and, still more, improvement demand a skilful combination of elaborate techniques. The statistician is necessary for design and for interpretation, the cytologist for exploration and creation, the geneticist for planning and direction. The discussion was chiefly useful in showing what the different levels of organization are and where each is required.

TUBERCULOSIS AND PULMONARY DISEASE

A RECENT issue of the *British Medical Bulletin* (2, No. 2; 1944) is devoted to pulmonary disease. It also contains two new features: one consists of notes from medical publications which are not classified as journals and the other lists the titles and authors of papers in medical journals published in Great Britain and Northern Ireland.

Dr. P. M. D'Arcy Hart, in a special article on the medical and social aspects of pulmonary disease, deals with tuberculosis and industrial diseases of the lungs. The Committee on Tuberculosis in War-time, set up by the Medical Research Council, reported that the social background of tuberculosis is of primary importance and emphasizes the part played by war-time conditions in the rise of mortality due to tuberculosis which has occurred between 1939 and 1941. Blackout, over-crowding, the movement of populations, destruction of homes by bombing, and the entry into industry of people who are not accustomed to its conditions and fatigue are all factors contributing to this rise. Nutritional deficiency is probably less important in this War than it was during 1914–18, because of our efficient national food policy. But working conditions should be carefully watched, especially those of young adults, who are especially susceptible to tuberculosis. The Committee recommends (1) routine mass radiography and advocates the miniature method pioneered by Abreu in Brazil, priority being given to young adults such as factory employees, medical students, nurses, merchant seamen; (2) special money grants to sufferers for at least a year to enable them to leave work, maintain their own standard of living and that of their families and to undergo treatment; (3) rehabilitation of convalescents and, if possible, their gradual return to work.

The Ministry of Health has already instituted the main recommendations of this report. War-time restrictions, Dr. Hart says, have limited the manufacture and issue of miniature radiography sets, but about half a dozen local authorities have received and are using them, and field trials are being carried out with them by a team appointed by the Medical Research Council. It is hard to understand why the manufacture of these sets should not be a first priority. The Ministry of Health's scheme of financial help is in general operation already. The general policy is one of continued watchfulness and avoidance of complacency which everyone will commend.

The Medical Rese⌐rch Council Committee on

Industrial Pulmonary Disease has studied the problem of silicosis in South Wales miners and also the environment of these workers. Dr. D'Arcy Hart summarizes the resultant additions to our knowledge of this problem and the Committee's recommendations. Readers interested in other work being done to increase the safety of the mines will find useful the Ministry of Fuel and Power's annual report for 1942 of the Safety in Mines Research Board (London: H.M. Stationery Office, 1943. 1*s.* net), which deals with work on coal-dust and fire-damp explosions, mining explosives, falls of ground, electrical researches and kindred problems.

In the same issue of the *British Medical Bulletin* Mr. R. C. Brock writes a valuable article on the present position of thoracic surgery. The advances in this field in recent years have been remarkable, and the surgical treatment of tuberculosis has an important place among them. Mr. Brock names X-rays and anæsthesia as the twin pillars of thoracic surgery, which requires of the surgeon such a wide knowledge of the anatomy and physiology of the chest as well as his essential pathological and medical experience. The anæsthetist has the especially difficult job of maintaining respiration and the circulation of the blood during operations on the very organs which maintain these essential functions. Mr. Brock thinks that, during the next ten years, we shall see advances in the surgery of the heart and œsophagus as great as those which have occurred in thoracic surgery during the past ten years. A good idea of the quality of the anatomical research on which thoracic medicine and surgery are based is given by the succeeding illustrated article on the anatomy of the bronchi by Dr. A. F. Foster-Carter. Excellent bibliographies add to the value of all these articles. They are supplemented by reviews of selected articles on pulmonary anatomy, surgery and disease, and on further papers on tuberculosis in children and on the statistical and social aspects of this outstanding scourge of our civilization.

The results of further important work on various aspects of tuberculosis have been published in *The Lancet* and the *British Medical Journal* during recent months and we know, from reports on the health of the occupied countries, how important a factor tuberculosis will be in the immense task of reconstruction after the War. A correspondent of *The Lancet* (Feb. 12, 1944, p. 225), taking his information from French underground medical papers, states that tuberculosis has increased in that country by at least 20–30 per cent. French medical men, moved to horror by the ever-increasing number of French workers deported to Germany who return with tuberculosis, are unable to save their lives because the necessary diets and drugs are not available. They are trying to sabotage the deportations by ordering long rest-cures, laboratory investigations, consultations with absent specialists and similar means. The discussion on nutrition in enemy-occupied Europe at the meeting of the Royal Society of Medicine on November 23, 1943 (*The Lancet*, Dec. 4, 1943, p. 703, and *Proc. Roy. Soc. Med.*, **5**, 37, Jan. 1944, p. 113) reveals a similar grave situation in Greece, Jugo-Slavia and Belgium. In the U.S.S.R. the problem is being tackled partly by village settlements similar to the English settlements at Papworth and Preston Hall, but the Russians appear to be concentrating on large-scale rehabilitation in and around the normal sites of industry (*Brit. Med. J.*, Nov. 20, 1943, p. 652).

G. Lapage.

SCIENCE CLASS CINÉ-FIL

A PARAGRAPH in the New of NATURE of November referred to a ciné-film showing th man move ment Dr. Quintin Moore, Mr. Thos. Smith Wylie and Mr. Frank G. Conway, of the Royal Technica College, Glasgow, have given the following particula regarding the method and apparatus.

Microscopical Unit. Through the courtesy of th Royal Technical College, Glasgo d the u of a 'Siedentopf' Cardioid Ult croscope (man factured by Carl Zeiss) toge r with associat apparatus.

The source of light was a 15-amp. carbon arc wi a horizontally positioned positive carbon. A converg ing lens projected the light as a parallel beam. Th light passed through a cooling chamber containing slightly acidulated 20 per cent ferrous ammonium sulphate solution, then directly to the 'Cardioid Condenser', which was fitted into the sleeve of th Abbe illuminator of the microscope. The top of th condenser was connected to the object slide by a layer of distilled water.

A 1 mm. thick quartz slide and quartz cove formed a chamber which was mounted in a meta holder and held firmly against the stage of th microscope. This quartz chamber resembles that o a hæmocytometer slide without engraved ruling; but the depth is considerably less, only 2–4 μ deep. A colloidal solution of Carey Lea's silver, suitably diluted, was placed on the centre of the object slid and excess solution overflowed into the surrounding channel. The dimensions of the colloidal silve particles were of the order of 50 mμ.

By careful adjustment and focusing, the oblique light from the condenser was made to illuminate completely the thin stratum of colloidal solution in th chamber. None of this oblique light can enter th microscope directly, due to the high numerical aper ture of the objective. The light which does enter i scattered from the surfaces of the colloidal particle and it passes into the following microscopical com bination: an apochromatic glycerine immersio objective adapted for use with the thick quart ove and of magnification 58, focal length 3 mm., an numerical aperture 0·85. The objective, carried by centring nosepiece, was used in conjunction with compensated focusing eyepiece, and the combinati gave a magnification of 1,160 diameters.

Photographic Unit. This consisted of a Bell-How 16 mm. camera fitted with a f 1·5 lens of 1 inch fo length.

The camera was mounted on a heavy base carefully set up so that the lens combinations o microscope and camera were in accurate co alignment. The camera lens set to infinity an full aperture was placed in a ground glass foc mount, which in turn was clamped to the eye of the microscope. Through this combination microscope was focused. The lens was then repla in the camera, maintaining the same relative positio of lens and eyepiece.

Kodak Super XX reversal panchromatic film w used with a camera frame speed of 4 per sec., givi an exposure of approximately ⅛ sec. per frame. N filters were used.

Excellent darkground effects were obtained wi the above equipment provided the requisite care w

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ent in weight of ... now be hired from the Scottish
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CONTROL OF ST. JOHN'S WORT IN AUSTRALIA*

By Dr. A. D. IMMS, F.R.S.

FIVE speci... ... John's wort (Hypericum) occur in Australia— ... inly in Victoria and New South ...ales. These species are *H. perforatum* L., *H. ...drosæmum* L., *H. calycium* L., *H. gramineum* ...orst. and *H. japonicum* Thunb. The first-named ... by far the most widespread and the chief pest. ...etween 250,000 and 400,000 acres of land in Victoria ...nd very large areas in New South Wales are in...ested with *H. perforatum*, and it also occurs in South ...ustralia, Tasmania and Western Australia. The ...pecies was introduced in 1870 in Victoria, and since ... occurs chiefly in hill and plateau country it is one ...f the most injurious of Australian weeds. Growing ...hickly, it eliminates all low-growing vegetation ...cluding pasture grasses, and some of the areas ...overed by the weed have had to be abandoned. ... is, furthermore, poisonous to stock.

Several methods of controlling *H. perforatum* have ...een adopted in Australia and some success has been ...hieved by the application of common salt at the ...te of ten, or more, tons to the acre. This treatment, ...owever, is too expensive for general use although ... is employed in Victoria to keep the roadsides free ...om the weed. The possibility of its repression by ...sects was first taken into account in 1917, and cer...in species of Hypericum-feeding insects were intro...ced in succeeding years from England. These were ...tain beetles of the family Chrysomelidæ—the ...ecies *Chrysolina varians* Schell., *C. brunsvicensis* ...ow. and *C. hyperici* Forst., all of which are leaf-...ders. The Geometrid moths *Anaitis efformata* ...en. and *A. plagiata* L., the larvæ of which feed ... the foliage of Hypericum, were also introduced ... England. None of these appeared to become ...bli... and the primary cause of the failure of ...st of them appeared to be climatic.

...ttention was then directed to Hypericum insects ...outhern France, where field observations showed ... a high degree of control is achieved in particular ...es by the Buprestid beetle *Agrilus hyperici* Creutz. ... the Chrysomelid beetle *Chrysolina gemellata* ...si. Supplies of both these species were shipped ...ralia in 1939 and 1940. The species *Chrysolina* ... disappeared for some years after its libera... ...ut has since been found in large numbers and ... firmly established in many areas.

...e of the other species of insects introduced ... England has apparently become established. ... *C. hyperici* now occurs in many localities, as ...t only occupies a mere fraction of the total ...ericum area of Australia. *C. gemellata* became ... readily established and spread and the *Agrilus* ...*erici* gives great promise and is increasing rapidly ...everal of the areas where its original liberation ... place in 1939 and 1940. At present, however, ...area actually covered by these last two species is even smaller than that covered by *C. hyperici*. There is every prospect that the three species named will eventually occur in all the St. John's wort areas. Their present limited distribution is naturally to be expected because they have only been introduced during a brief period. The retrogression of the weed where *C. hyperici* is numerous and the continuous increase in the numbers of this insect, together with the ease with which the other species (*C. gemellata* and *A. hyperici*) have become established, give ground for confidence that a useful degree of control of the weed will, in time, be achieved.

...he Entomological Control of St. John's Wort (*Hypericum per-...m* L.) by Frank Wilson. Bull. No. 169 Council for Scientific ... ndustrial Research (Melbourne, 1943).

STRUCTURE, FUNCTION AND SYNTHESIS OF POLYSACCHARIDES*

A NEW chemical synthesis of cellobiose by a simple and direct method has been accomplished by Stacey and Gilbert. The structure of the repeating unit in cellulose is therefore well established, and the microbiological synthesis of the polysaccharide was achieved by Hibbert. Starch, another functional material of the plant, is recognizable as two structural types of polysaccharide: amylose giving the deep blue coloration with iodine and representing about 25 per cent of natural starch, and amylopectin, the remaining 75 per cent, giving a reddish-blue colour. Amylose, synthesized both by plant and muscle phosphorylase, is represented as a continuous chain of maltose units and this is completely hydrolysed to maltose by β-amylase. Amylopectin is also composed of maltose units in shorter chains which are united as a laminated or branched-chain structure, and this is hydrolysed in stages to maltose and various dextrins. The factor responsible for the synthesis of amylopectin has not yet been isolated, but attempts have been made in this direction. Products related to amylopectin have been obtained by Dr. Peat, but their identity is not yet established.

Many of the specific and somatic bacterial polysaccharides contain amino-glucose and uronic acids as constituent units. The constitutional relationship of these polysaccharides is only partly revealed, although some synthetic analogues which are bioses are seen also to have antigenic properties. Structurally related to these are the polysaccharides produced by non-pathogenic organisms such as Rhizobia; and the plant gums which also contain uronic acid groups.

Heparin, the blood anti-coagulant factor of liver, contains glucosamine and glucuronic acid units together with acetyl and sulphate residues. The chondroitin of cartilage is similar in the composition of its individual units except that galactosamine (or talosamine) replaces glucosamine.

The synthesis of the levans by enzymes has been frequently reported; their constitution is now established, as is also that of the dextrans from *Penicillium luteum* and *Leuconostoc dextranicum*. These are 1 : 6-glucopyranose polymers.

B. welchii, the gas gangrene organism, is convertible into a Gram-negative form by sodium cholate ex-traction. The Gram-positive character can be... stored by combination with the magnesium ... ribonucleic acid. The constitution of both ... and desoxy-ribonucleic acid is partly reveal... recognition of ribo- and desoxyribofuran... the mode of combination of which, wheth... or linked units, is not yet known.

* Substance of the Bakerian Lecture deliver... Society by Prof. W. N. Haworth, F.R.S., on Ju...

FORTHCOMING EVENTS

Saturday, June 24

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (joint meeting with the SCIENTIFIC FILMS ASSOCIATION) (at the Large Theatre, Ministry of Information, Malet Street, London, W.C.1), at 3 p.m.—Discussion on "The Construction and Presentation of Scientific Films". (Mr. Arthur Elton: "The Scope and Distribution of Scientific Films"; Mr. Geoffrey Bell: "Shooting Scientific Films"; Dr. J. Yule Bogue: "The Production of Scientific Films for Medical and Biological Purposes".)

Tuesday, June 27

SOCIETY OF CHEMICAL INDUSTRY (NUTRITION PANEL) (at the Chemical Society, Burlington House, Piccadilly, London, W.1.), at 2.30 p.m.—"The Taste and Quality of Food in relation to Nutrition". (Prof. H. Hartridge, F.R.S.: "The Physiology of Taste and Smell and its Nutritional Significance"; Dr. G. W. Scott Blair: "The Assessment of Food Quality by Handling"; Dr. D. R. Davis: "The Subjective Effect of Food in relation to its Nutritional Value"; Mr. R. R. Plowman: "The Art of Tea-Tasting").

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibition of specimens and discussion.

Saturday, July 1

INSTITUTE OF PHYSICS (LONDON AND HOME COUNTIES' BRANCH) (in the Physics Department, Imperial College of Science and Technology, South Kensington, London, S.W.7), at 2 p.m.—Conference on "Applied Spectroscopy". (Prof. H. Dingle: Introductory Address; Mr. F. Twyman, F.R.S.: "Spectroscopic Instruments"; Mr. D. M. Smith: "Spectrographic Analysis"; Dr. W. A. Roach: "The Determination of Mineral Deficiencies and Excesses in Plants by Spectrographic Analysis"; Dr. R. W. B. Pearse: "Applications of Molecular Spectra").

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APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

ASSISTANT PHYSICIST in the Physics Department—The Secretary, Royal Cancer Hospital (Free), Fulham Road, London, S.W.3 (July 1).

CHEMICAL ENGINEER for Aluminium Powder and Paste Works (location, Middlesex)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2149XA) (July 1).

TWO MECHANICAL ENGINEERS with good technical and practical experience in Heavy Engineering (Reference No. C.2155XA), and a MECHANICAL ENGINEER with good technical and practical experience in Heavy Engineering plus ability to act as Assistant to Responsible Executive (Reference No. C.1994XA)—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate No.) (July 5).

ASSISTANT MECHANICAL ENGINEERS for the Tanganyika Government Railways—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2170A) (July 5).

CHIEF ENGINEER, Port of Basrah—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.756A) (July 5).

ASSISTANT TECHNICAL OFFICER by the Agricultural Lime Department of the Ministry of Agriculture and Fisheries—The Ministry of Labour and National Service, Room 432, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. O.N.F.1808A) (July 8).

LECTURER OR SENIOR LECTURER IN GEOGRAPHY, and an ASSISTANT LECTURER IN GEOGRAPHY—The Registrar, The University, Manchester 13 (July 10).

LECTURER (temporary) IN MINING, a LECTURER (temporary) IN MINERAL DRESSING, and a LECTURER (temporary) IN ENGINEERING—The Professor of Mining, Royal School of Mines, Prince Consort Road, London, S.W.7 (July 15).

DIRECTOR OF THE OTAGO SCHOOL OF MINES (University of Otago)—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 21).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street ..., London, E.C.2 (July 31).

...MATING AND COSTING SURVEYOR OR ENGINEER by small but ...blished firm of Civil Engineering Contractors, E. London ... Ministry of Labour and National Service, Appointments ..., Sardinia Street, London, W.C.2 (quoting Reference ...).

...AL ENGINEER by Liverpool firm manufacturing textile ...mical processes—The Ministry of Labour and National ...ointments Office, Cotton Exchange Buildings, Liverpool 3 ...rence No. A.O.128).

...THE ROYAL INSTITUTE OF CHEMISTRY—Prof. A. ... Royal Institute of Chemistry, 30 Russell Square,

REPORTS

(*not includ...*

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Abstracts of Dissertations approved f... Degrees in the University of Cambridge ... 1942–1943. Pp 40. (Cambridge: At ...

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Rural Housing: Third Report of the ... of the Central Housing Advisory Committ... Stationery Office.) 1*s*. net.

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Imperial College of Tropical Agriculture: ... Research Station. Memoir No. 20: Studies in ... Carbohydrate Metabolism of the Banana Fru... under Tropical Conditions, by H. R. Barnell, ... Metabolism of the Banana Fruit during Storage at ... at 68° F., by H. R. Barnell; 14: Carbohydrat... Banana Fruit during Storage at 53° F., by H. ... (Trinidad: Imperial College of Tropical Agricultu...

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Astronomical Papers prepared for the use of the ... and Nautical Almanac. (Published by the Naut... U.S. Naval Observatory, by direction of the ... and under the authority of Congress.) Vol. 11, ... Mercury, 1765–1937. Pp. 221. (Washington, ... Printing Office.) 65 cents.

Education and Research. Three Editorials re... *History Magazine*, November 1943–January 19... Pp. 14 (New York: American Museum of Natu...

National Geological Survey of China. Palaeo... Series D. No. 10 (Whole Series No. 127): The ... pekinensis; a Comparative Study on a Primitive ... By Franz Weidenreich. Pp. xxi+485 (93 plates ... Stechert and Co.)

U.S. Office of Education: Federal Security ... Reports of the United States Office of Education ... 1941–42, 1942–43. Pp. viii+88. (Washington, D.C. ... Printing Office.) 15 cents.

Proceedings of the American Philosophical Society ... January 29, 1944: Symposium on the Organization ... Support of Research; Papers read before the A... Society, Autumn Meeting, November 19–20, 1943 ... (Philadelphia: American Philosophical Society.)

U.S. Office of Education: Federal Security Agency ... No. 1: Education in Cuba. By Severin K. Tur... (Washington, D.C.: Government Printing Office.) ...

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Proceedings of the United States National ... 3172: The Catfishes of Venezuela, with Descri... New Forms. By Leonard P. Schultz. Pp. 173–3... ington, D.C.: Government Printing Office.)

Smithsonian Institution: Bureau of American ... 133: Anthropological Papers, Nos. 19–26. ... 1 dollar. Bulletin 136: Anthropological Papers ... viii+375+32 plates. 75 cents. (Washington ... Printing Office.)